

**NASA
Reference
Publication
1227**

1989

**The 1989 Airborne Arctic
Stratospheric Expedition
Nimbus-7 TOMS Data Atlas**

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National Aeronautics and
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Office of Management
Scientific and Technical
Information Division

THE 1989 AIRBORNE ARCTIC STRATOSPHERIC EXPEDITION:

THE NIMBUS-7 TOMS DATA ATLAS

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1. INTRODUCTION

1.1 The 1988 Airborne Arctic Stratospheric Expedition

Over the past several years, world scientific attention has been focussed on the rapid and unanticipated decrease in the abundance of ozone over Antarctica during the Austral Spring. A major airborne campaign was conducted during August and September of 1987 which directly implicated man-made chemical compounds, chlorofluorocarbons, in the ozone loss over the southern hemisphere. A second major aircraft campaign was conducted from December 1988 to February 1989 in response to the recently published Ozone Trends Panel Report which found that the largest decreases in Arctic ozone occurred during January to February at latitudes near the edge of the Arctic vortex.

The primary objectives of the 1989 Airborne Arctic Stratospheric Expedition were to: (1) study the production and loss mechanisms of ozone in the north polar stratospheric environment and (2) study the effect on ozone distribution of the Arctic polar vortex and of the cold temperatures associated with the formation of Polar Stratospheric Clouds (PSCs). These objectives were to be achieved by flying specially instrumented DC-8 and ER-2 aircraft from a base in Stavanger, Norway. Scientists in Stavanger planned the aircraft flights with the aid of meteorological forecasts of air parcel trajectory and potential vorticity as well as near-real-time total ozone analyses from the TOMS instrument aboard Nimbus-7.

1.2 The Nimbus-7 TOMS Experiment

Background information on the Nimbus-7 TOMS experiment, as well as the processing used to produce hemispheric and orbital total ozone contour plots may be found in Krueger et al. (1988).

2. TOMS DATA PREPARATION AND TRANSFER

The near-real-time processing and transfer of TOMS ozone data commenced on December 27, 1988 and concluded on February 16, 1989. The processing involved two data sets: (1) complete southern hemispheric data for the 24 hours ending at midnight of the day prior to transmission and (2) orbital swath data for the region from Greenland to Scandinavia.

2.1 Data Available to Stavanger

The orbital swath data consisted of 2 to 3 orbits daily, which were processed and transferred to Stavanger as they were received. Selection of the particular orbits was effected well in advance through the use of predictive ephemeris to generate tables of the orbital ascending-node times and longitudes and plots of the orbital subsatellite tracks. Telemetry from the Nimbus-7 spacecraft was downlinked to one of NASA's network of spaceflight tracking stations, such as at Wallops Island, Goldstone, Madrid, or Canberra, and then transmitted over the NASA Deep-Space Network to the Goddard Space Flight Center (GSFC). The raw TOMS data from each orbit were received at the Mission Operations Control Center (MOCC) in Building 3 at the GSFC and placed onto magnetic tape. This tape was then manually transferred to the NASA Space and Earth Sciences Computing Center (NSES CC) in Building 1 at the GSFC where the raw data were processed into total ozone and reflectivity data on an IBM 3081 computer in Ozone-T standard tape format.

The ozone data were copied to the dedicated TOMS MicroVAX II computer in Building 21 at the GSFC via an Ethernet connection. At this point, the orbital swath data were processed prior to release to Stavanger. This processing included the gridding of the calibrated Ozone-T data to create an image file, with further processing to display the image file. Once the image was viewed and deemed acceptable, the Ozone-T data files, one for each of up to three orbital swaths, were then transferred via DECnet and two Concord 296 Trellis forward error-checking modems at 9.6 kilobits/second (kbps) to a second MicroVAX II located in Stavanger. The orbital-swath processing required approximately 30 minutes. The total elapsed time between the actual Nimbus-7 pass over the orbital area and the receipt of total ozone data in Stavanger varied between 3 and 4 hours. Once received at Stavanger (and at GSFC as well), the data were plotted using a Tektronix 4692 plotter and 4208 color graphics terminal and a standardized color look-up

table. The color plots facilitated comparison and permitted rapid interpretation of day-to-day changes in the ozone pattern.

The hemispheric data were processed in a similar fashion, but the elapsed time was greater. A full duration of 24 hours is required for the Nimbus-7 TOMS to obtain global (or southern hemispheric) coverage. The hemispheric data set, containing total ozone data from a complete day of Nimbus-7 orbits, was available to the TOMS MicroVAX by approximately 10:00 AM of the following day, or 10 hours after Nimbus-7 completed its last orbit of the day. This data set was gridded on the IBM 3081 in Grid-T format and required minimal further processing prior to transfer. The hemispheric ozone data were also transferred to the Stavenger MicroVAX II via a DECnet link.

2.2 Data Analysis and Presentation

An atlas of the TOMS coverage of 1987 Antarctic Airborne Ozone Experiment, background information on the Nimbus-7 TOMS Experiment, as well as the processing used to produce hemispheric and orbital total ozone contour plots, may be found in Krueger et al. (1988).

3. TOMS TOTAL OZONE DATA

3.1 Chronology of the Experiment

DECEMBER 26, 1988

This is the first day for which a TOMS hemispheric image was obtained in near-real-time. Total ozone values below 275 DU are located over southern Norway and Sweden and the adjacent North Sea. Maximum values above 400 DU are located over New Brunswick, Canada and the western Pacific.

DECEMBER 28, 1988

A relative minimum continues to be located over the southern Baltic and adjacent North Sea. Minimum values below 250 DU are observed. Maximum ozone values above 450 DU are located over the USSR Pacific Coast.

JANUARY 3, 1989

The minimum over the Scandinavian countries continues to persist. The area with total ozone values below 275 DU has expanded to cover much of western Europe with the Scandinavian countries and adjacent waters below 250 DU. Maximum ozone values above 475 DU are located over the northeastern USSR.

JANUARY 7, 1989

The Scandinavian minimum has moved to the east and has been replaced by total ozone values of about 300 DU. A large maximum persists over the northeastern USSR and adjacent north Pacific with ozone values above 475 DU.

JANUARY 11, 1989

A new relative minimum is located over the southern Scandinavian, North Sea area, with total ozone values below 275 DU. Maximum values in excess of 425 DU are located over the north central USSR and over the southern Canadian plains.

JANUARY 25, 1989

During the past two weeks, several small minima traversed the Scandinavian countries with total ozone values below 275 DU. Commencing January 23, a more significant minimum has been developing in the region. Total ozone values are now below 200 DU over a very small area of Finland, with most of northwestern Europe experiencing values below 250 DU. Maximum ozone values are located over the Bering Sea and are above 525 DU.

JANUARY 29, 1989

The strong minimum over Scandinavia has moved eastward over the north central USSR and filled. A new minimum, with total ozone values below 275 DU has developed over Great Britain. Maximum ozone values above 525 DU are located over northern Hudson Bay and over the USSR Pacific coast.

FEBRUARY 1, 1989

By this time, the weak minimum over Great Britain has deepened rapidly, and expanded. Total ozone values below 275 DU cover most of western Europe, with values below 200 DU covering most of Scandinavia. Minimum values below 150 DU are located over northern Sweden and Norway. The TOMS measurements of total ozone in this region are interfered with by high stratospheric clouds. At the same time, maximum values of 450 to 525 DU cover most of Canada. At this time, much of northern and western North America was experiencing record high surface pressure and cold.

FEBRUARY 4, 1989

The minimum over Scandinavia which produced the lowest apparent total ozone values of the experiment has filled and moved over the northwestern USSR. Total ozone values over the Yukon Territory of Canada are now below 275 DU, a reduction of 225 DU in four days. Maximum ozone values above 550 DU are located over the Pacific coast of the USSR.

FEBRUARY 8, 1989

Total ozone values over central Norway and Sweden now exceed 425 DU. The minimum over the Yukon has moved southeastward over the plains of Canada. Maximum ozone values persist over the Pacific coast of the USSR.

FEBRUARY 15, 1989

A very pronounced maximum has expanded over the north Atlantic to include much of northern Europe. Total ozone values above 550 DU are located just west of Norway. Minimum values below 275 DU persist over northwestern North America. The persistent maximum over northeastern USSR contains total ozone levels above 500 DU.

FEBRUARY 17, 1989

Maximum ozone values over the north Atlantic between Greenland and northern Norway now exceed 600 DU. Minimum values below 275 DU persist over north central Canada. The polar vortex has, at this time, split into two vortices; one coincident with the Canadian ozone minimum, the other appearing as an ozone minimum projecting from the polar night at 120°E longitude.

FEBRUARY 21, 1989

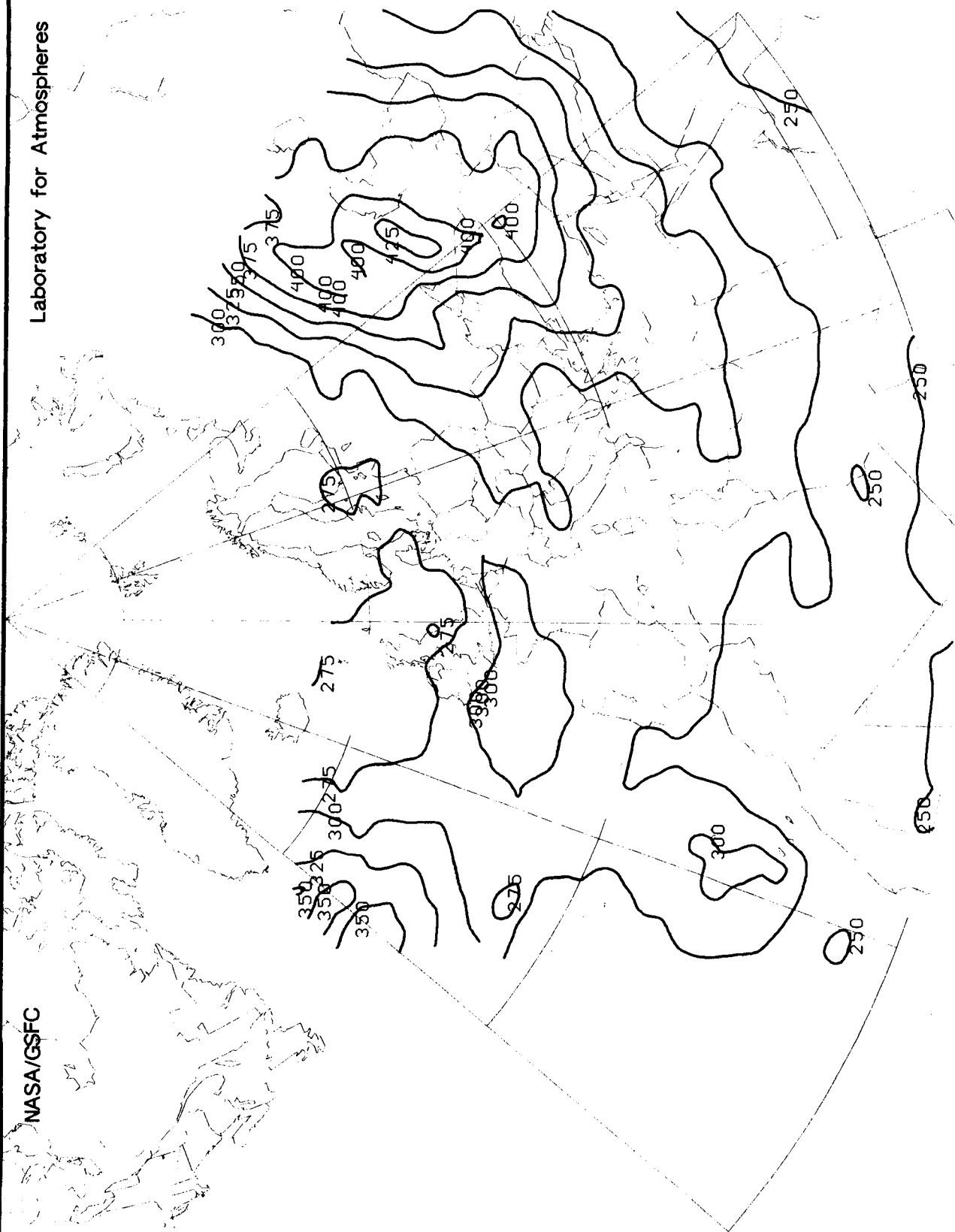
The two lobes of the polar vortex are now clearly defined as a circular total ozone minimum over eastern Siberia and as a second minimum centered over Baffin Island.

FEBRUARY 23, 1989

As the terminator retreats northward toward the pole, very high total ozone values above 450 DU cover the polar regions. Ridges of high ozone values extend southward from the polar region like spokes of a wheel. These maxima are surrounded by generally steep ozone gradients. This pattern persists into mid-March 1989. The Siberian lobe of the vortex remained nearly fixed in location until the end of February. The Canadian lobe at the same time drifted across Greenland to western Europe before becoming lost in meteorological noise.

3.2 Near-Real-Time Orbital Charts

A set of orbital TOMS total ozone plots for a northern hemisphere domain covering western Europe, North Africa, and the eastern North Atlantic is presented here. The daily data, over the period December 27, 1988 through February 16, 1989 on the uniform 2° latitude by 1.5° longitude grid for each day, and include those orbits incorporating measurements which were of interest to the experiment for near-real-time mission planning purposes.

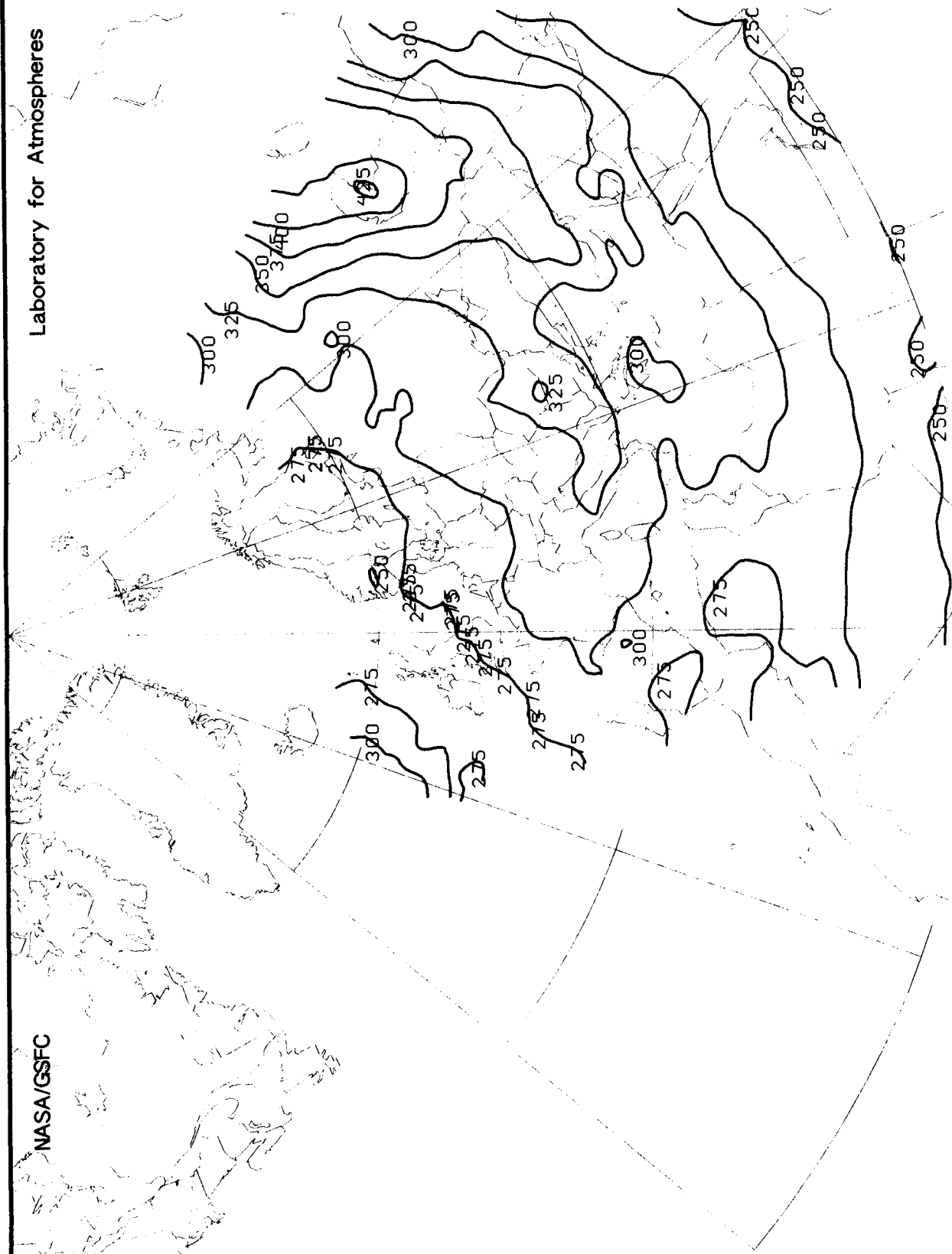


December 27, 1988

Orbital (51379-51382) TMS Ozone (Dobson units)

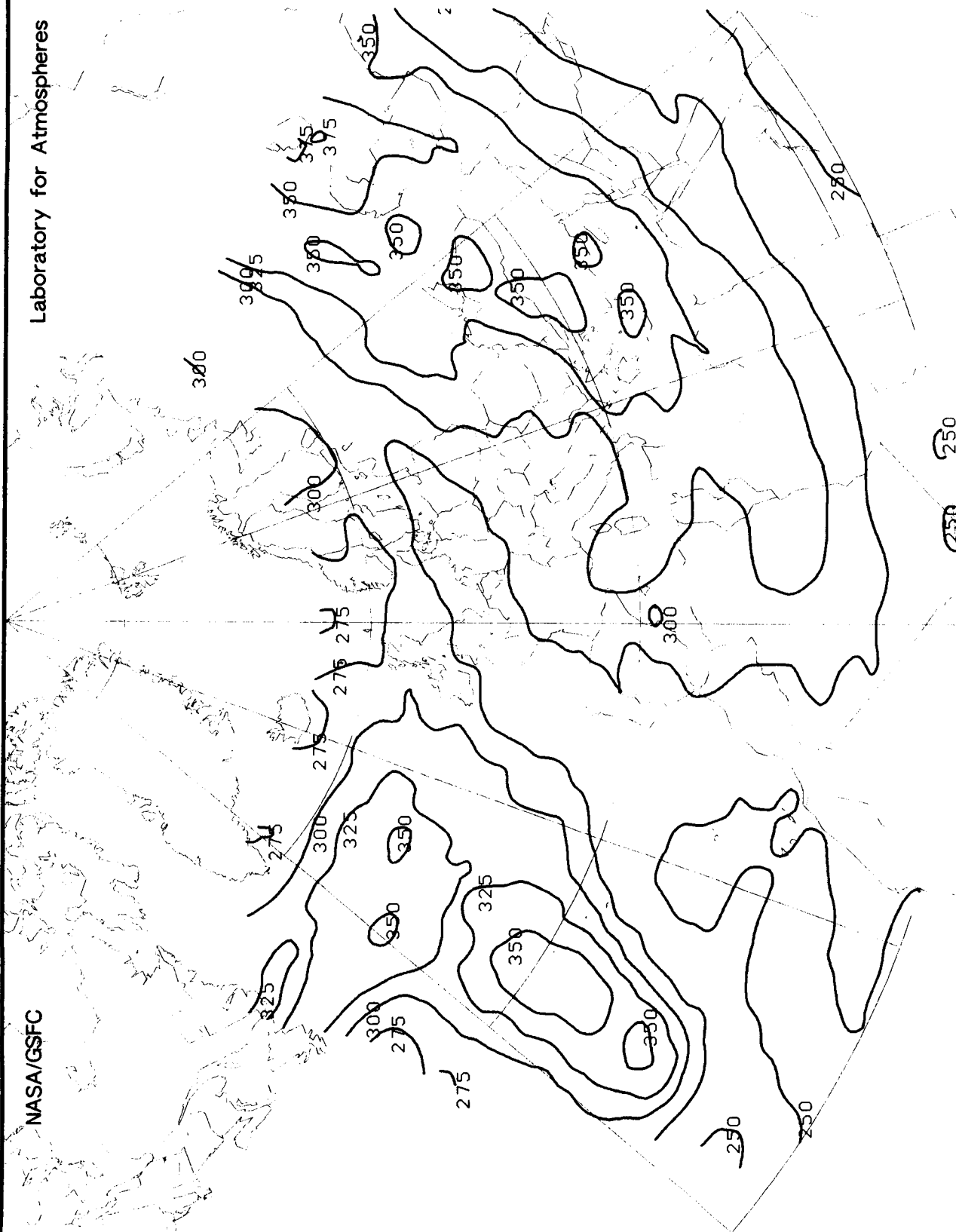
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December 28, 1988

Orbital (51393-51396) TOMS Ozone (Dobson units)

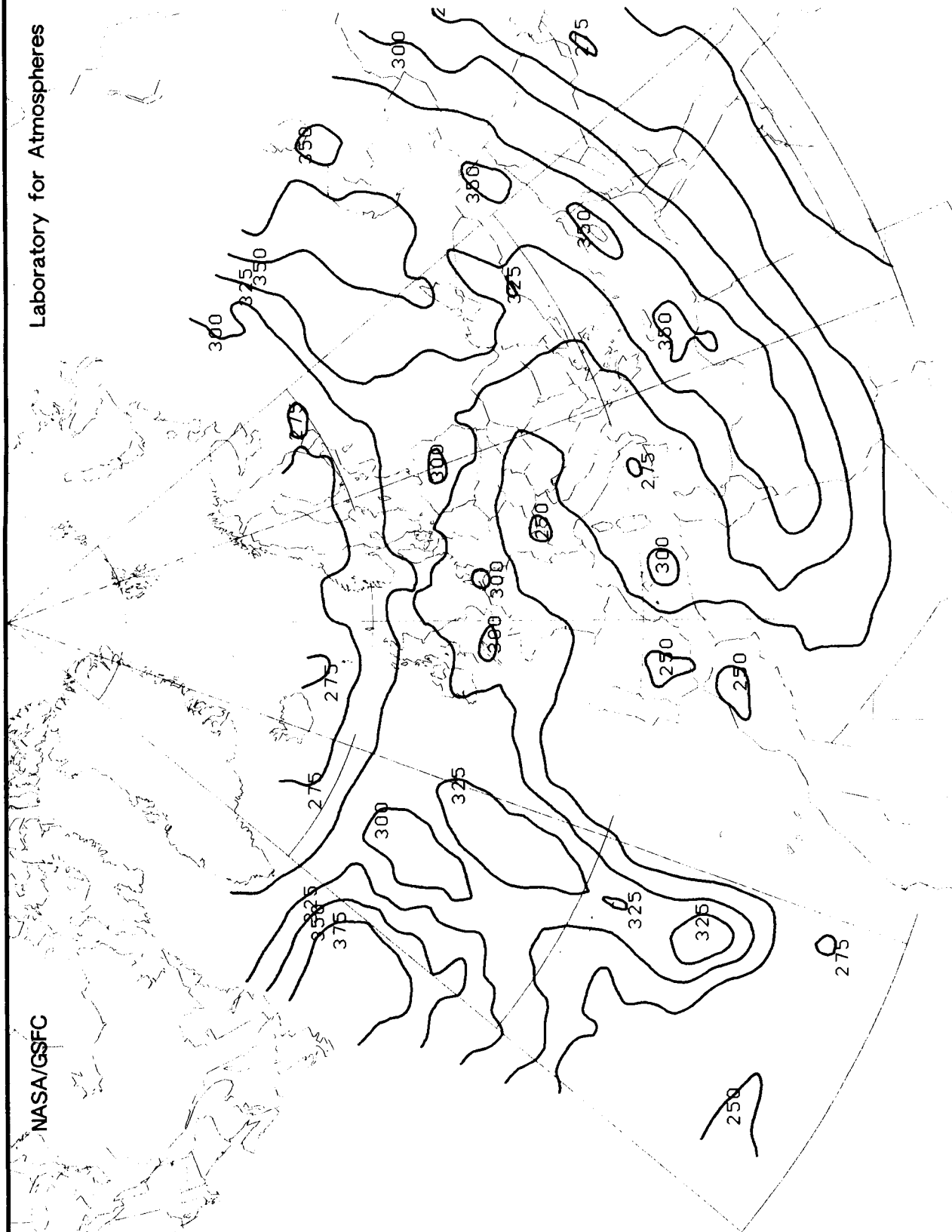


December 29, 1988

Orbital (51407-51410) TOMS Ozone (Dobson units)

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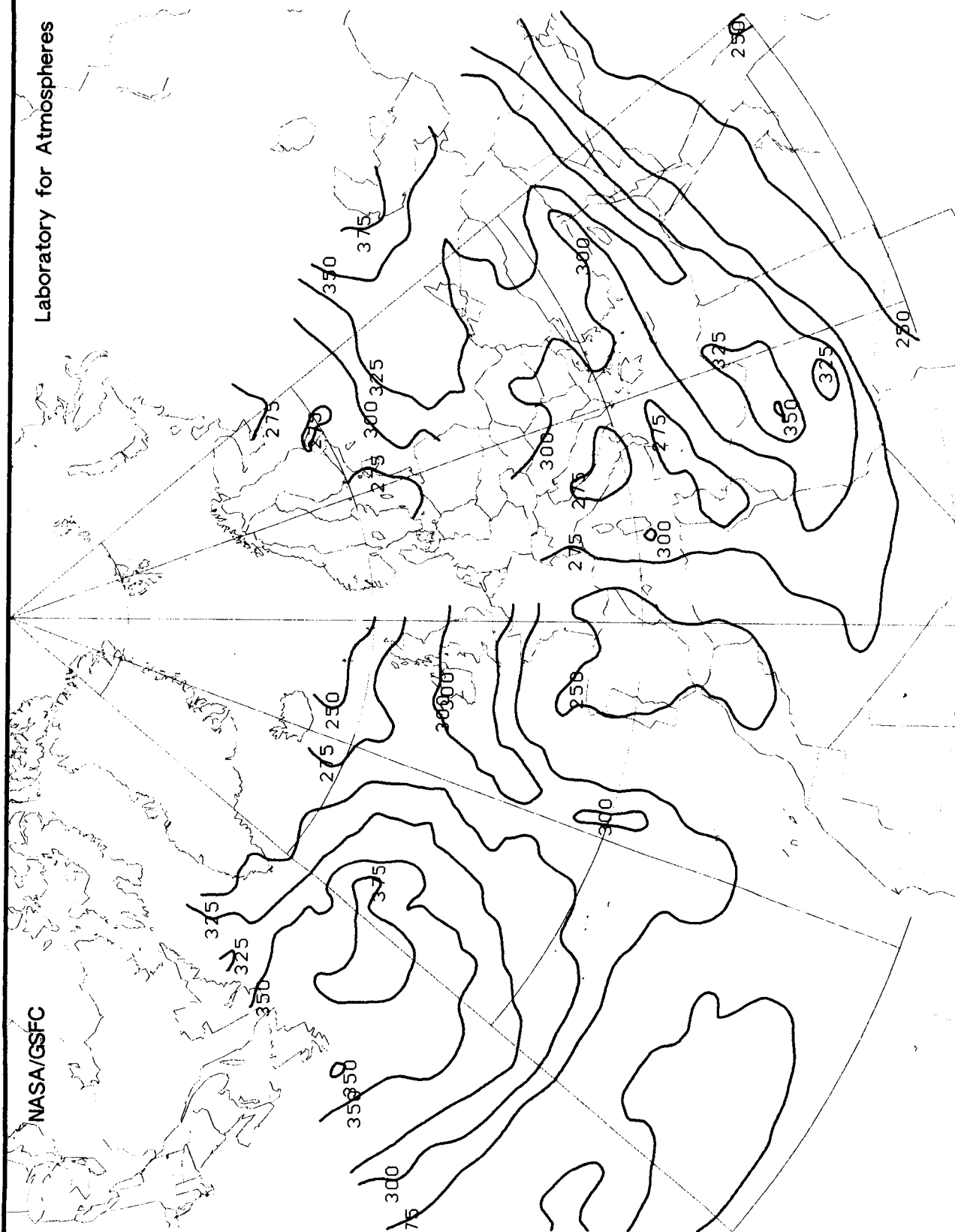


December 30, 1988

Orbital (51421-51425) TOMS Ozone (Dobson units)

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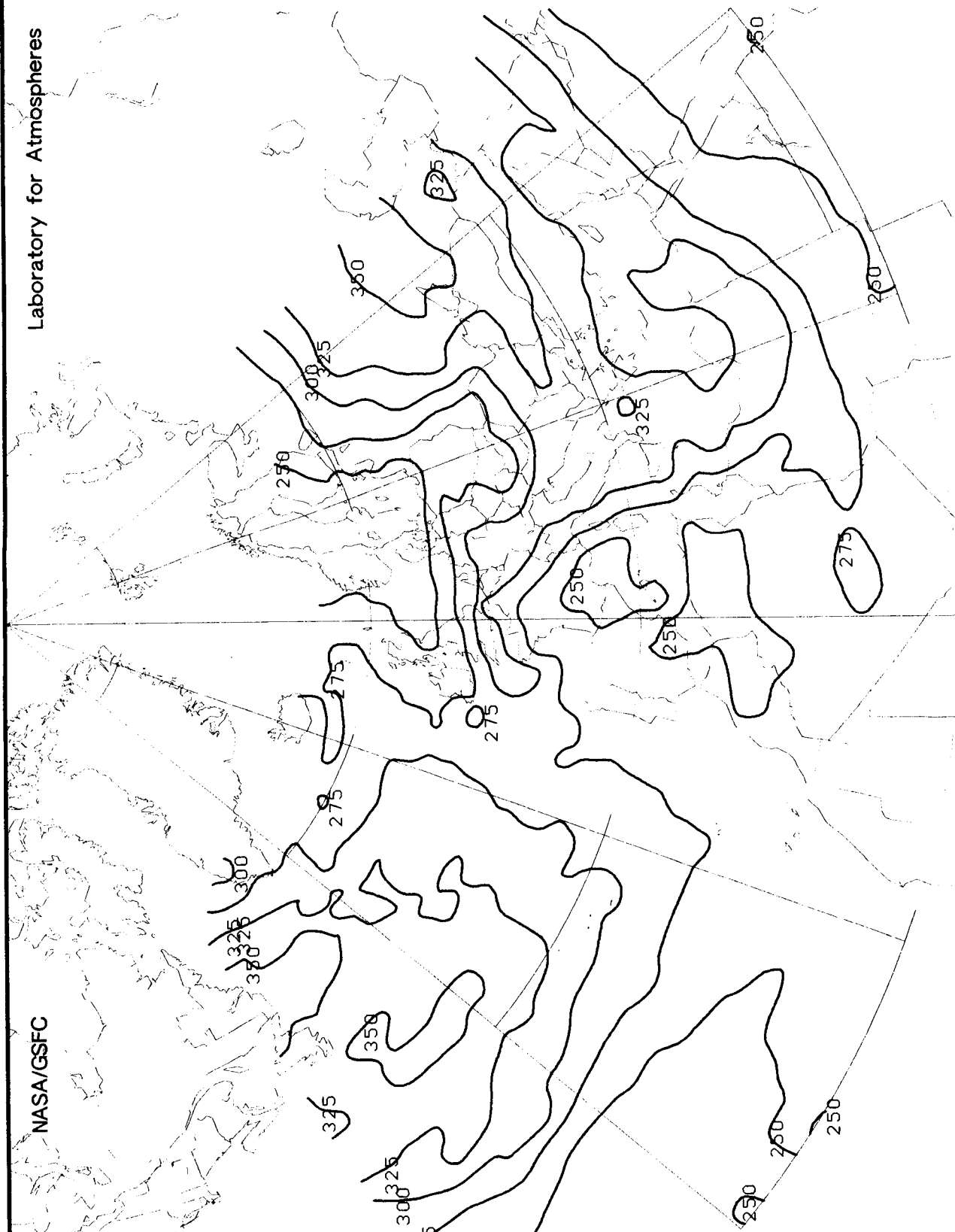


December 31, 1988

Orbital (51436-51438) TOMS Ozone (Dobson units)

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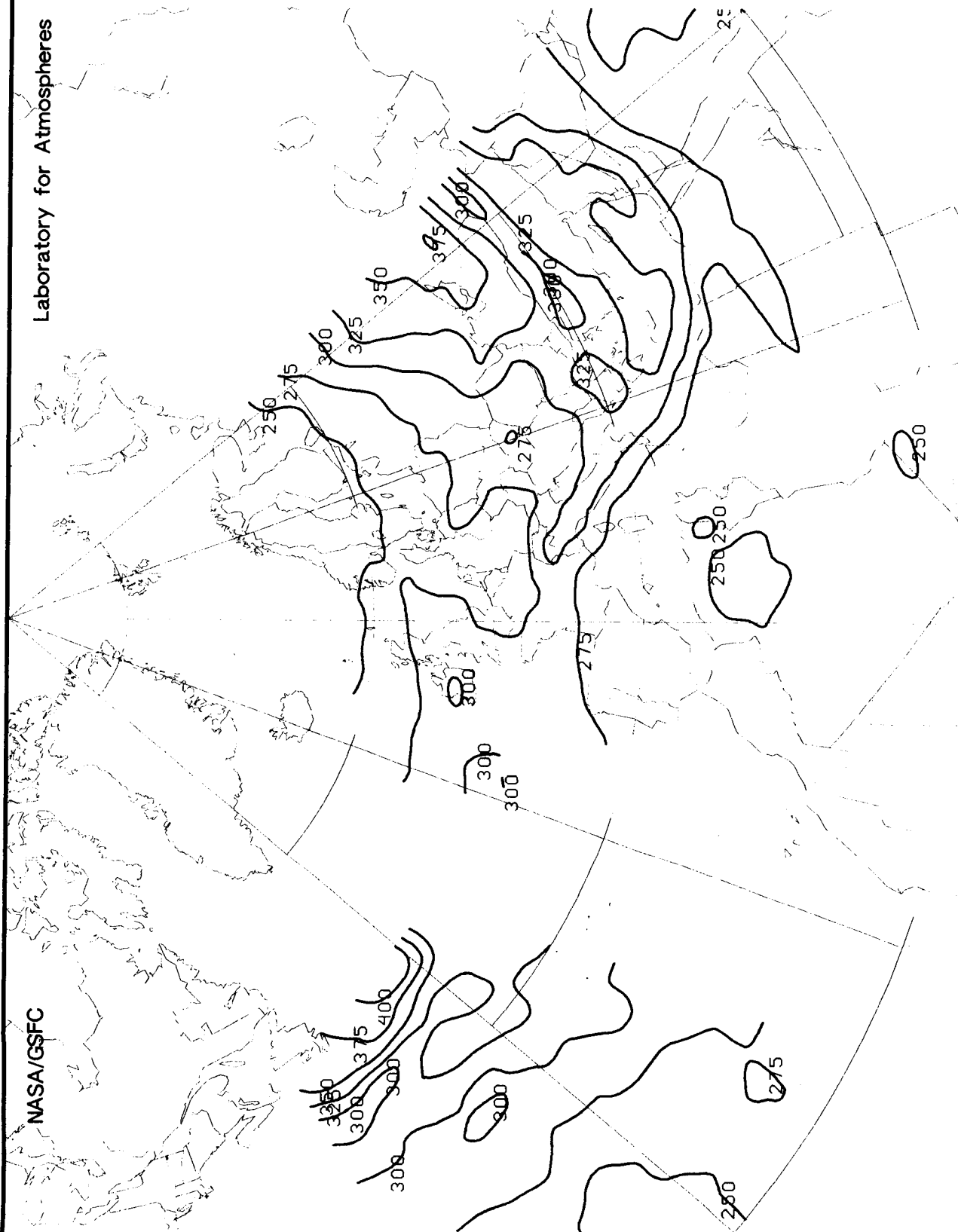


January 1, 1989

Orbital (51449-51452) TOMS Ozone (Dobson units)

NASA/GSFC

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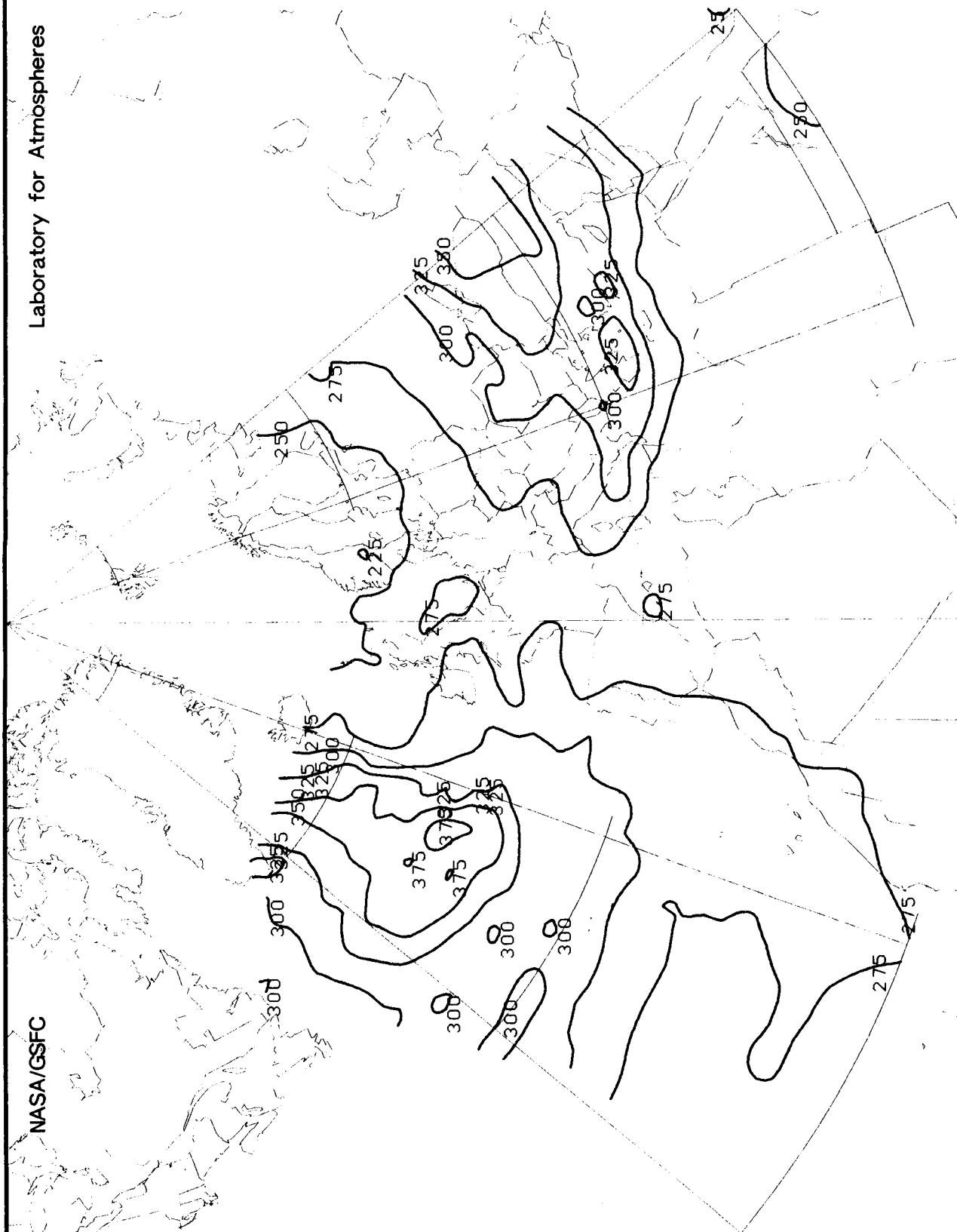


January 2, 1989

Orbital (51463-51467) TOMS Ozone (Dobson units)

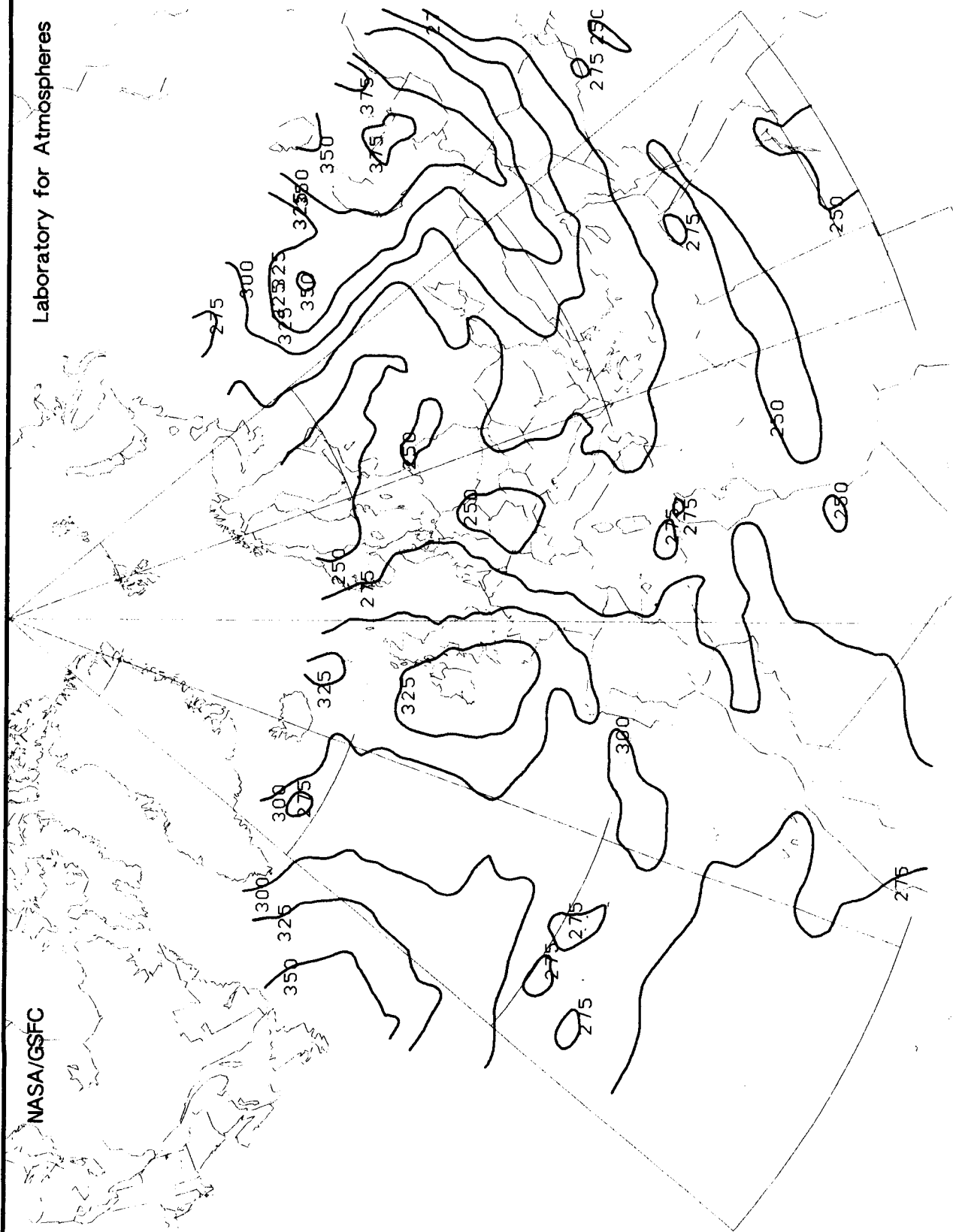
NASA/GSFC

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January 3, 1989

Orbital (51477-51479) TOMS Ozone (Dobson units)

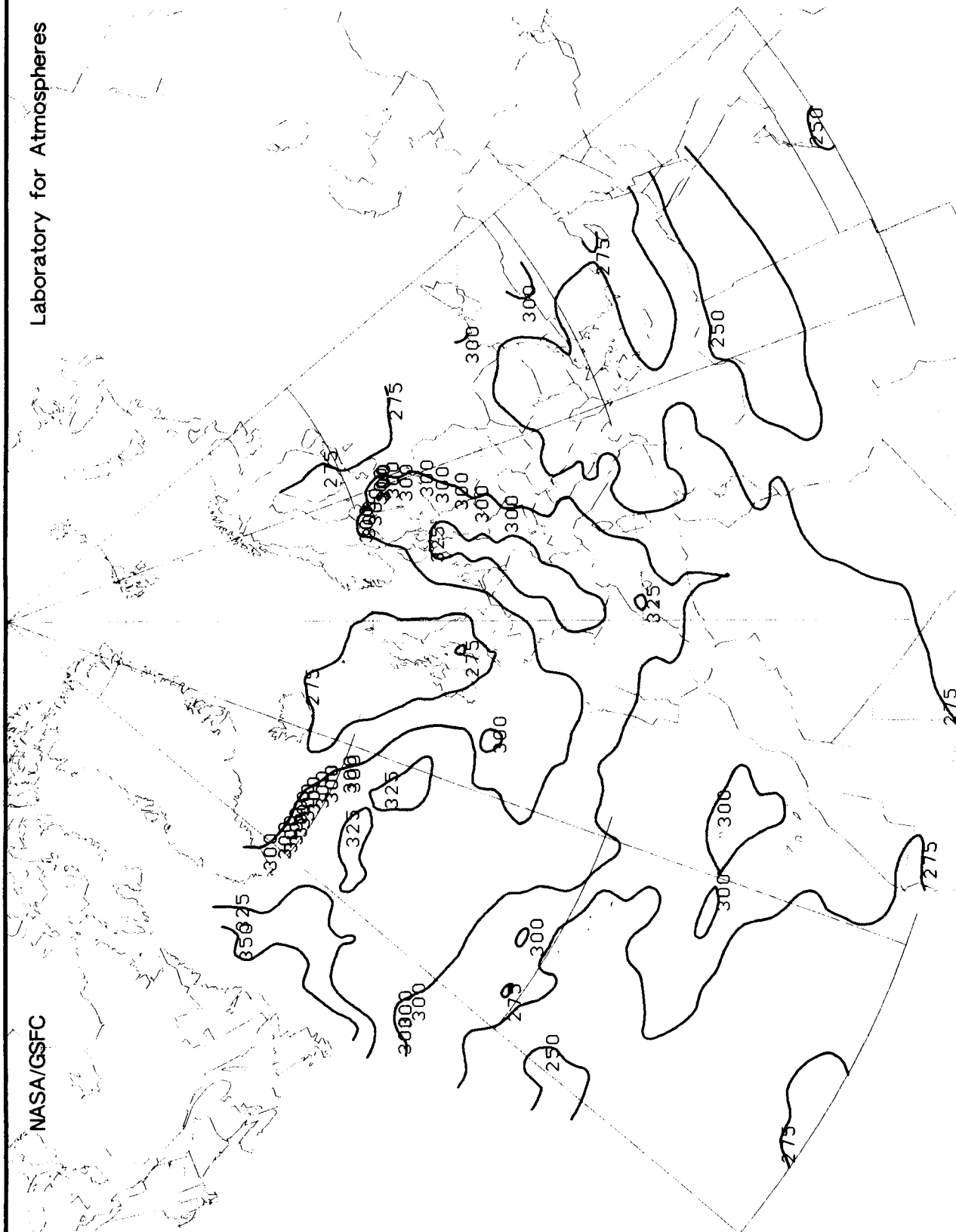


January 4, 1989

Orbital (51490-51493) TOMS Ozone (Dobson units)

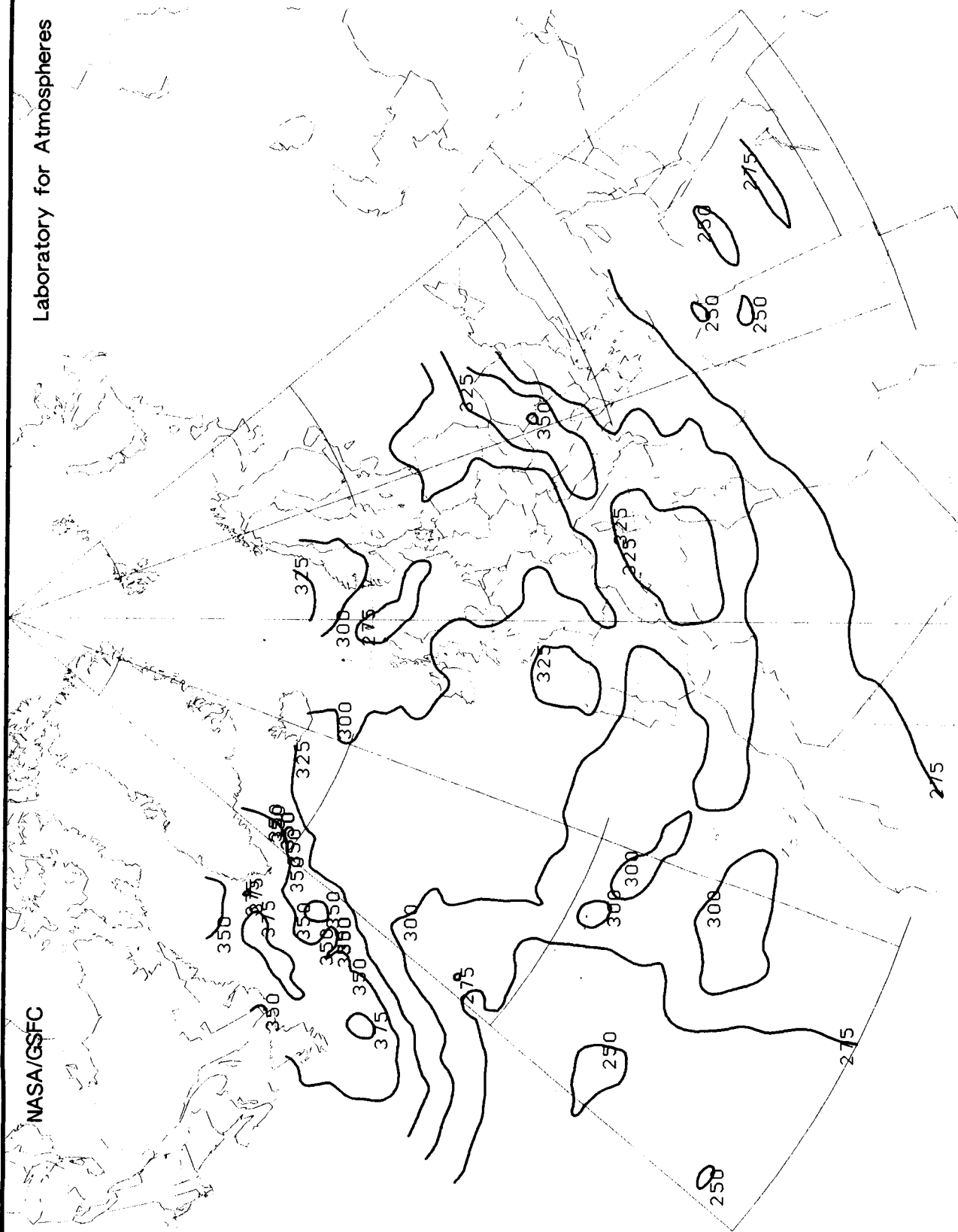
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January 5, 1989

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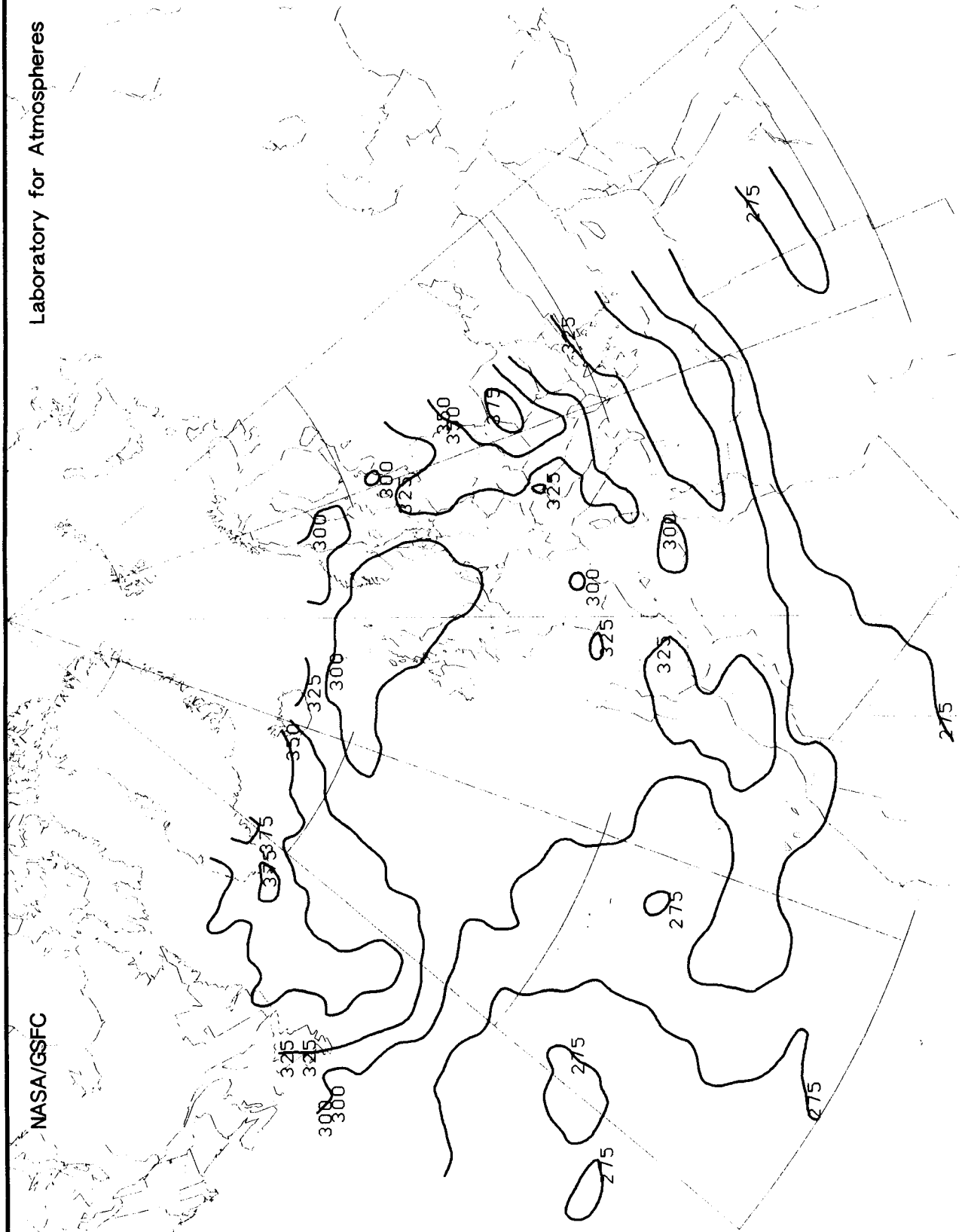


January 6, 1989

Orbital (51519-51521) TOMS Ozone (Dobson units)

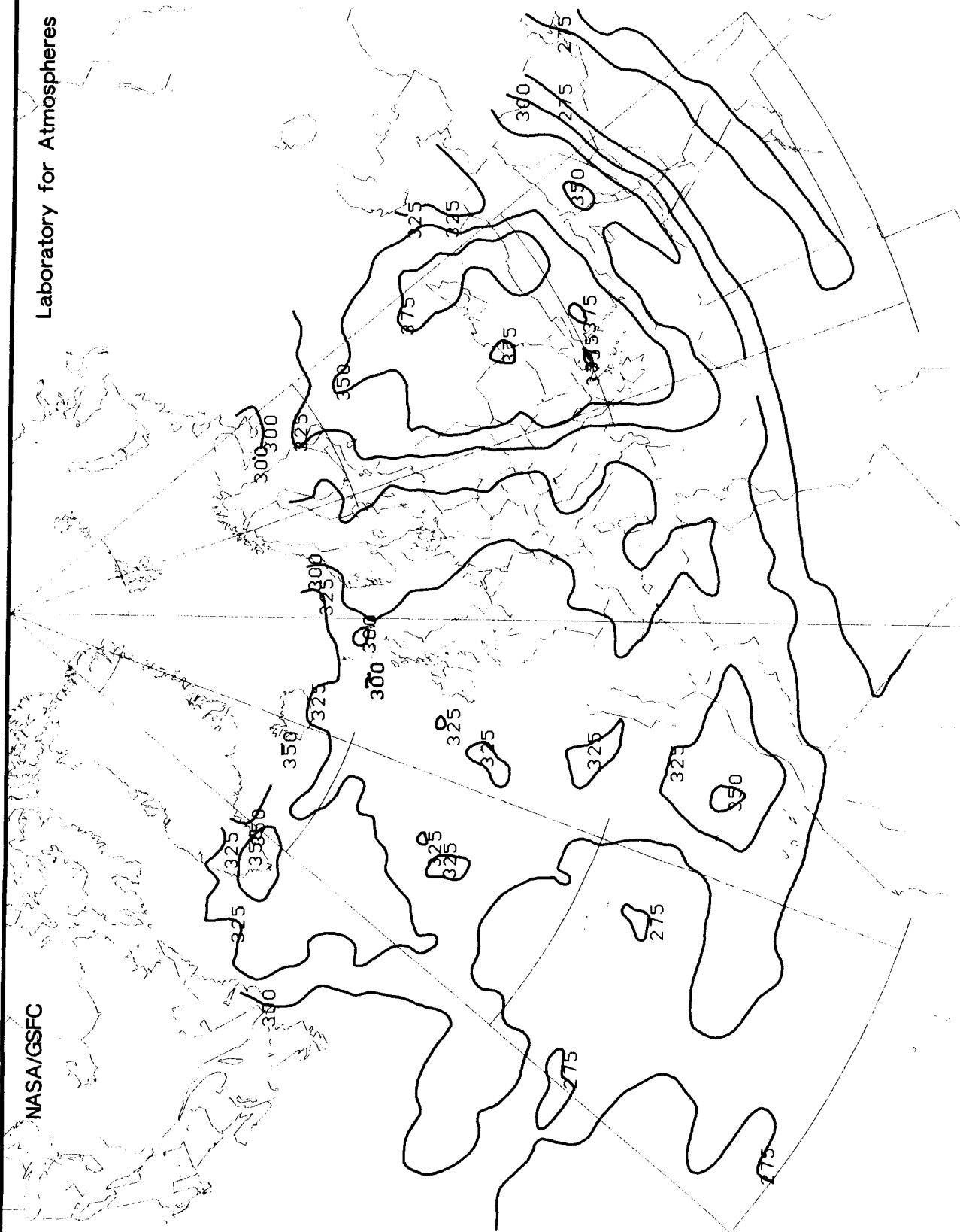
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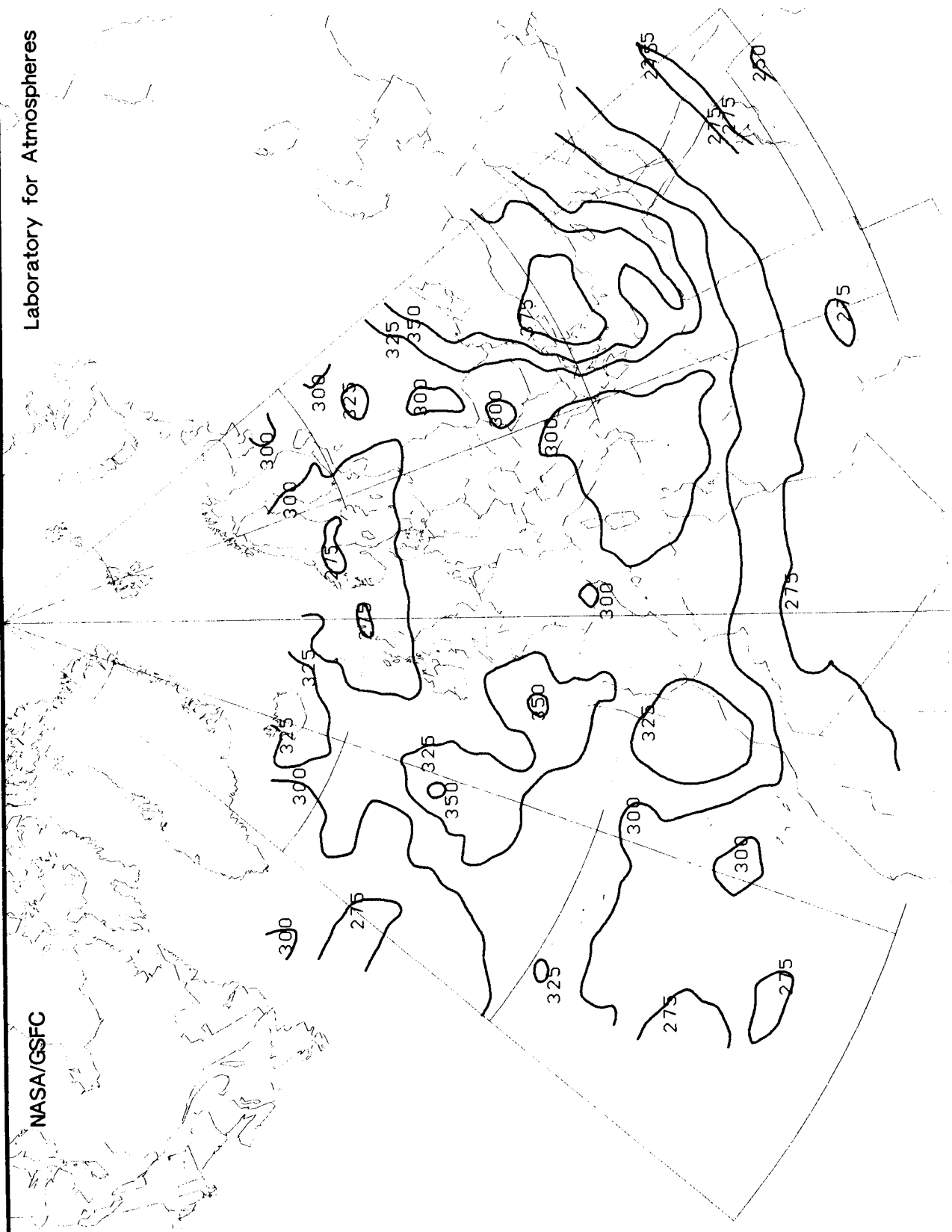


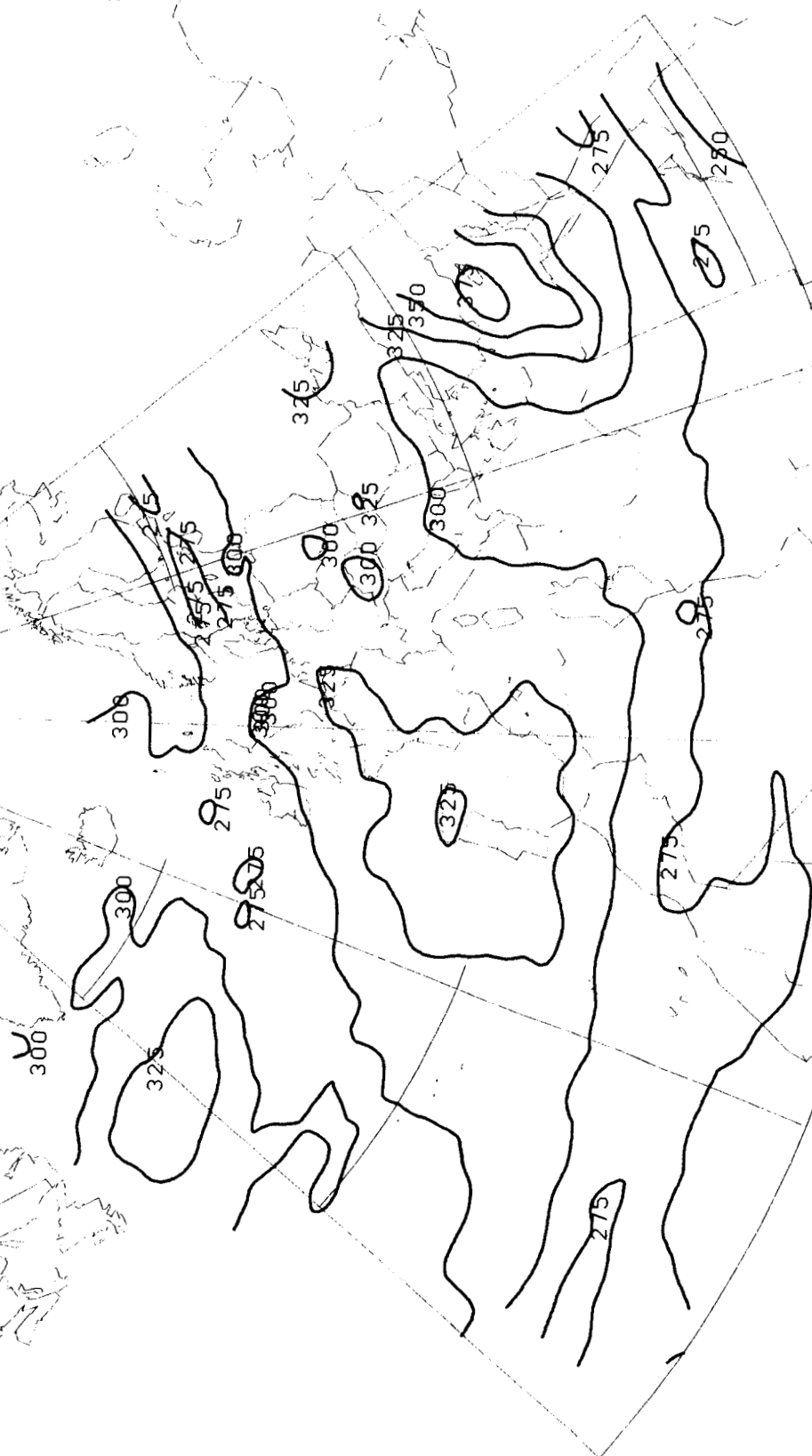
January 7, 1989

Orbital (51533-51535) TMS Ozone (Dobson units)



January 8, 1989



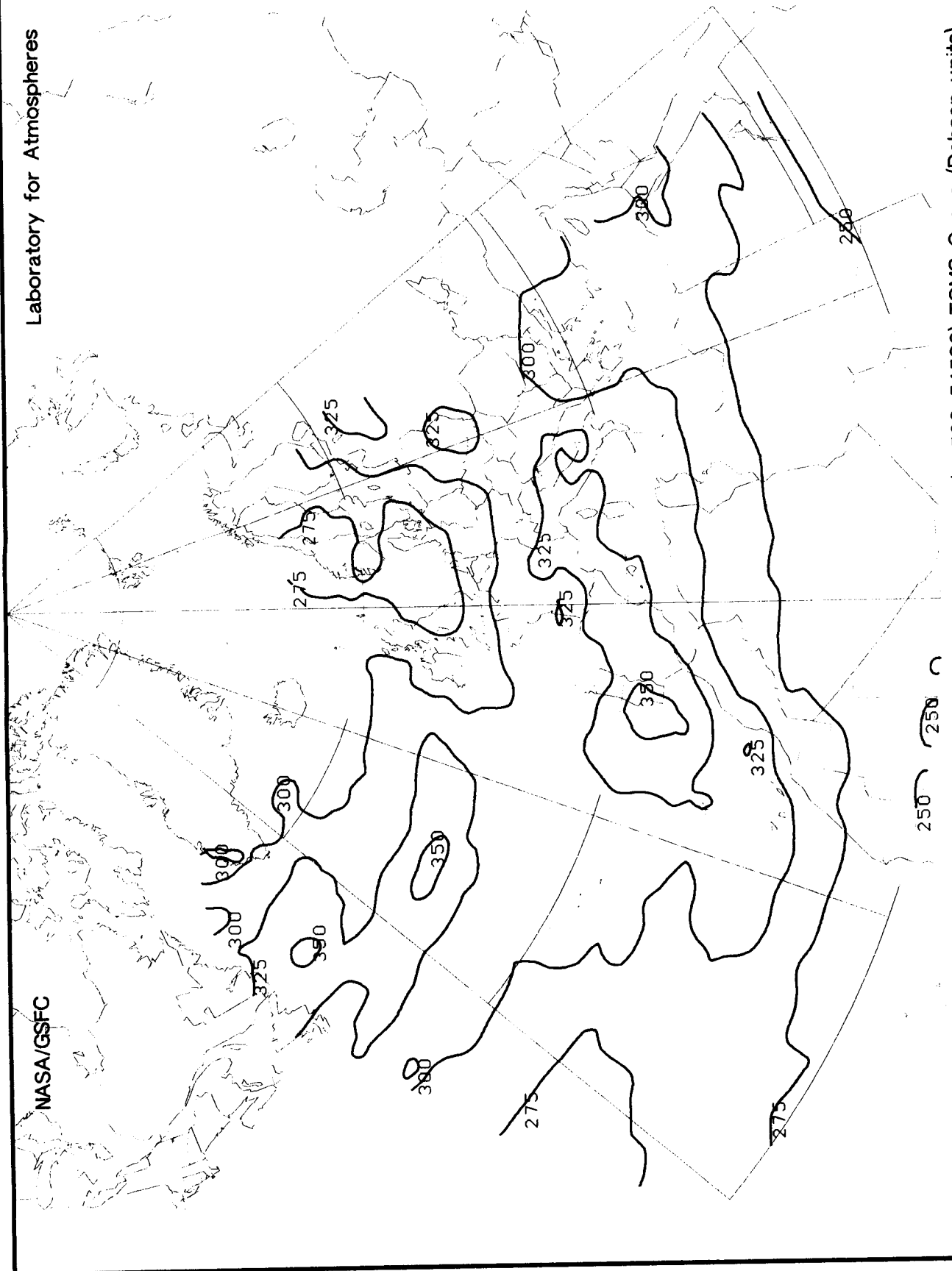


January 10, 1989

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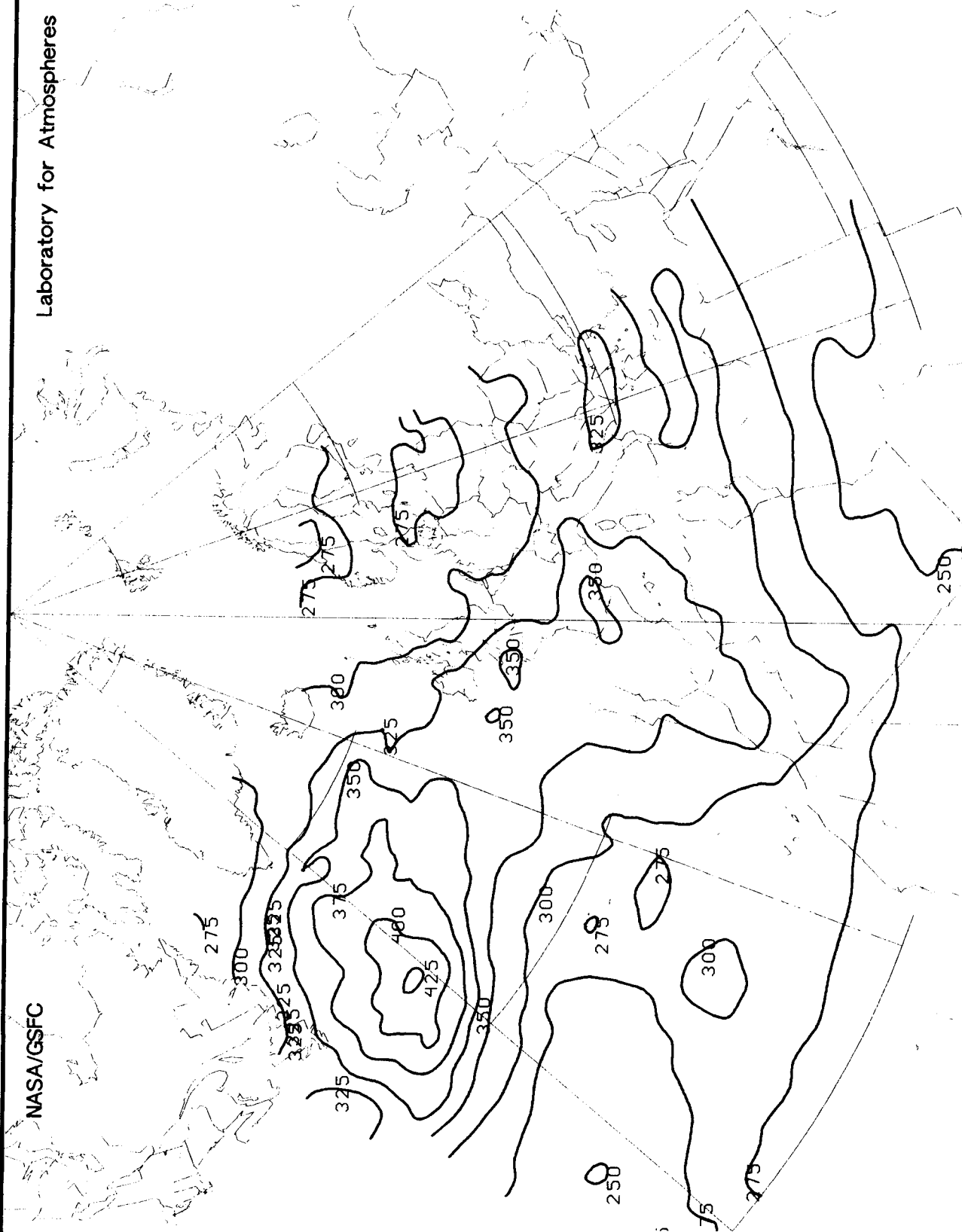
NASA/GSFC

Laboratory for Atmospheres



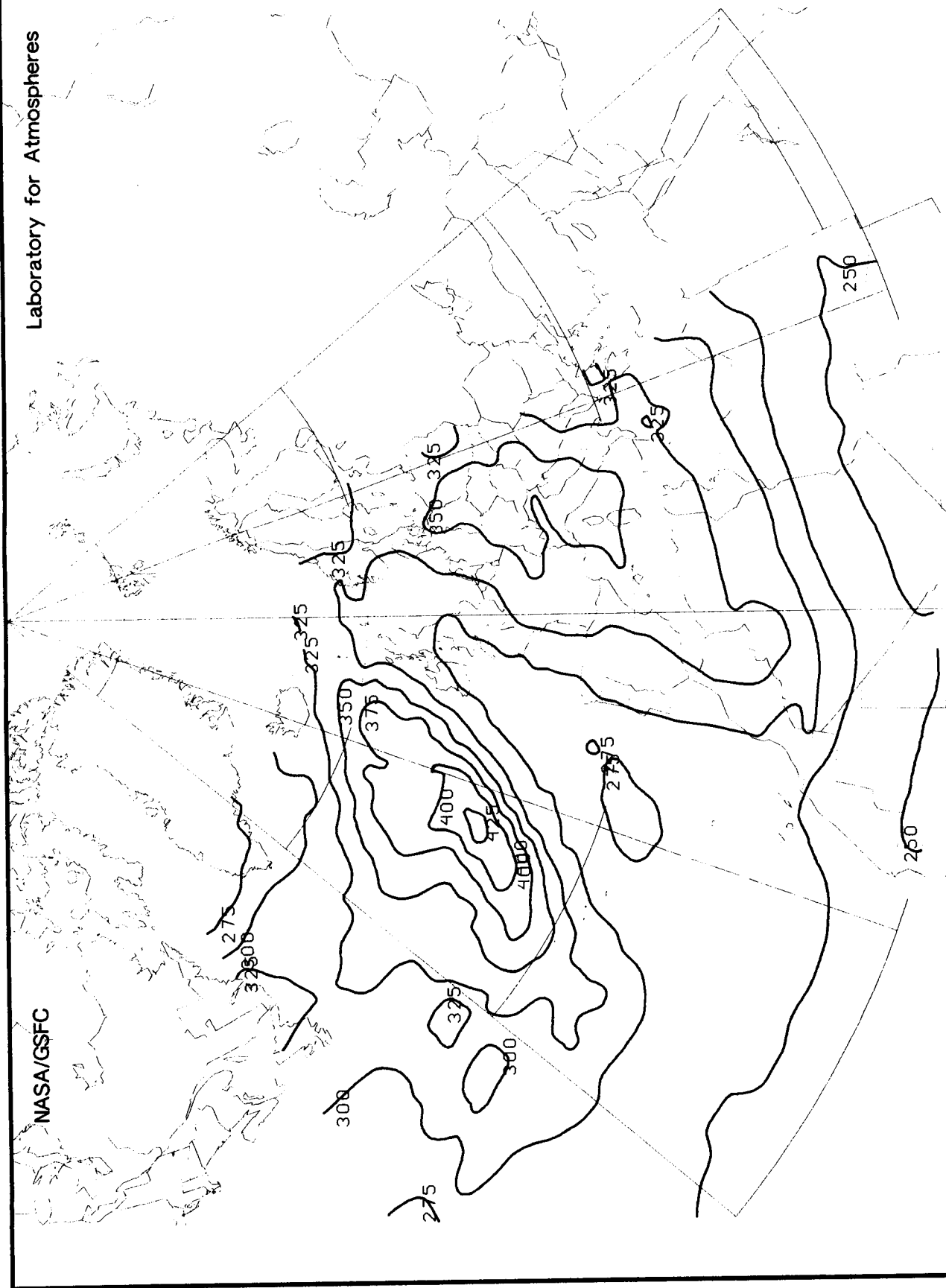
January 11, 1989

Orbital (51588-51590) TOMS Ozone (Dobson units)



January 12, 1989

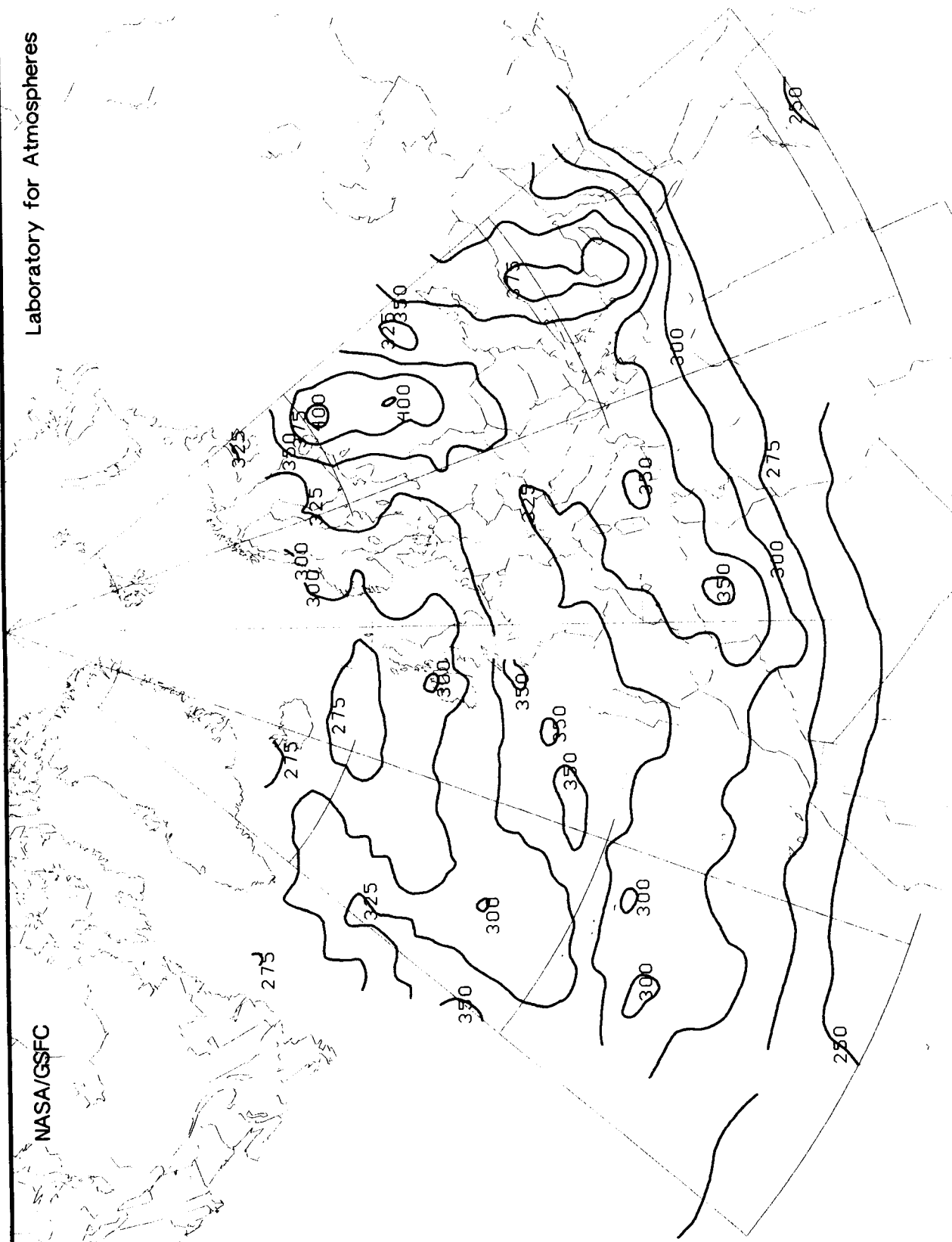
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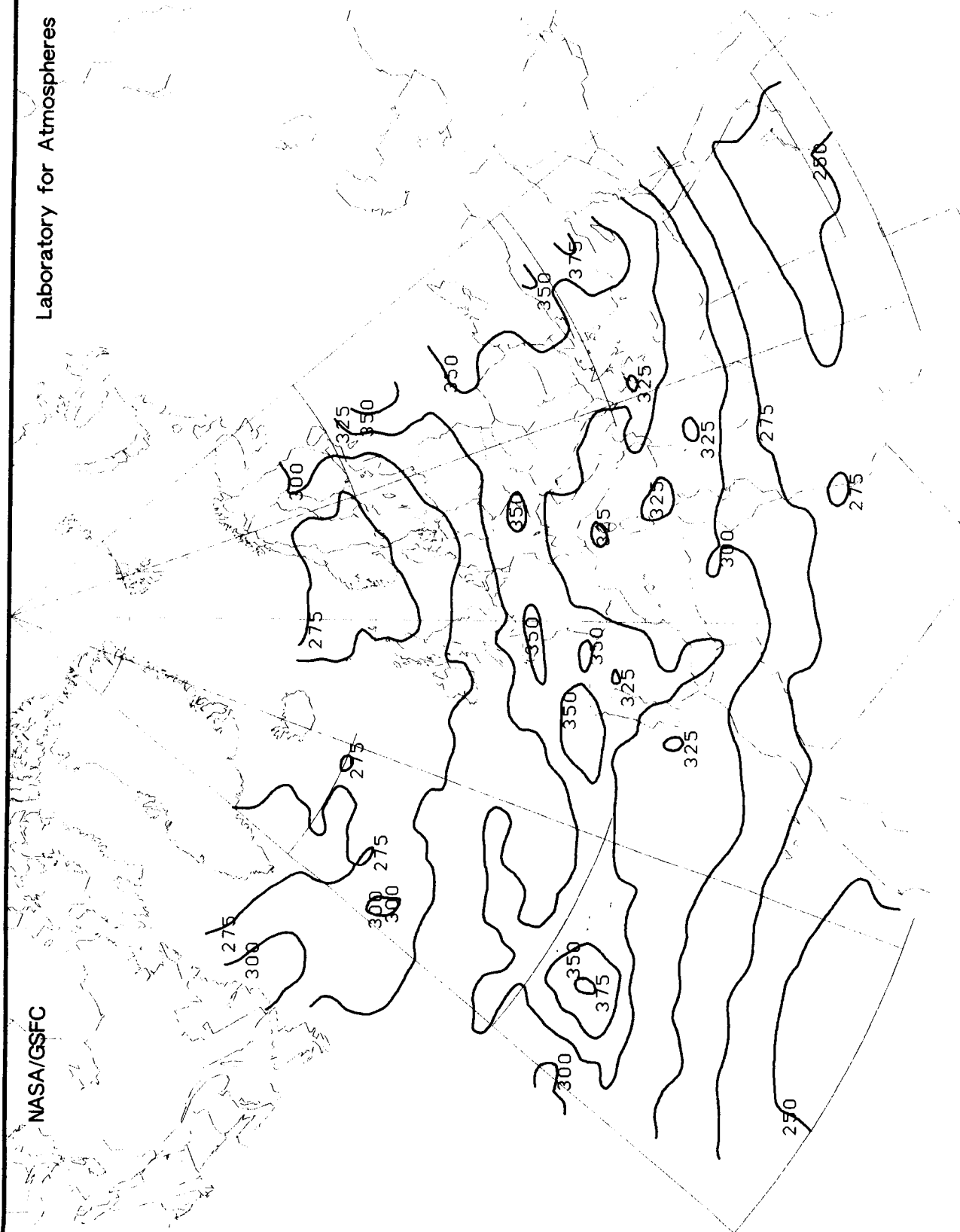




January 14, 1989

Orbital (51629-51633) TMS Ozone (Dobson units)



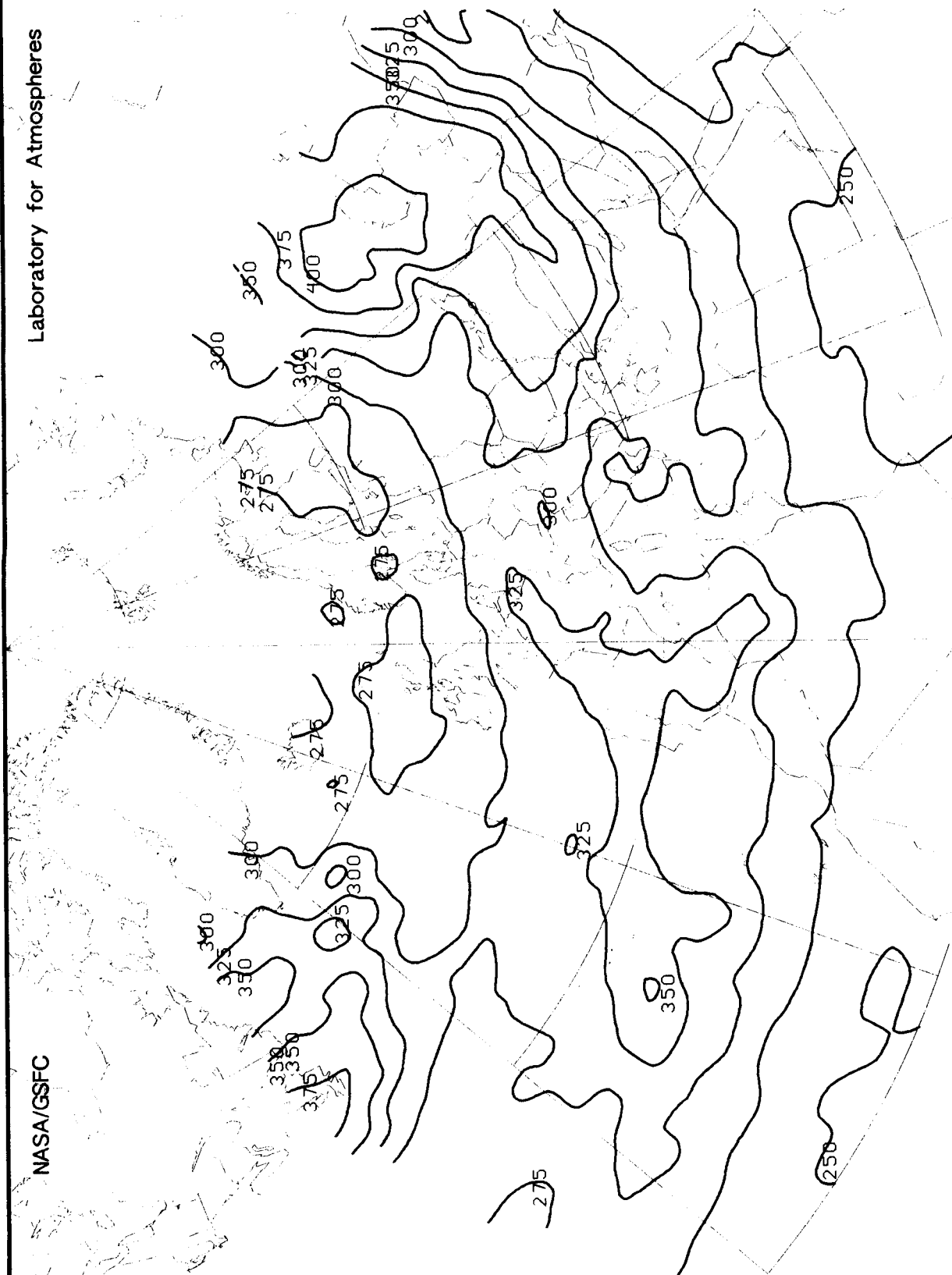


January 16, 1989

Orbital (51657-51659) TMS Ozone (Dobson units)

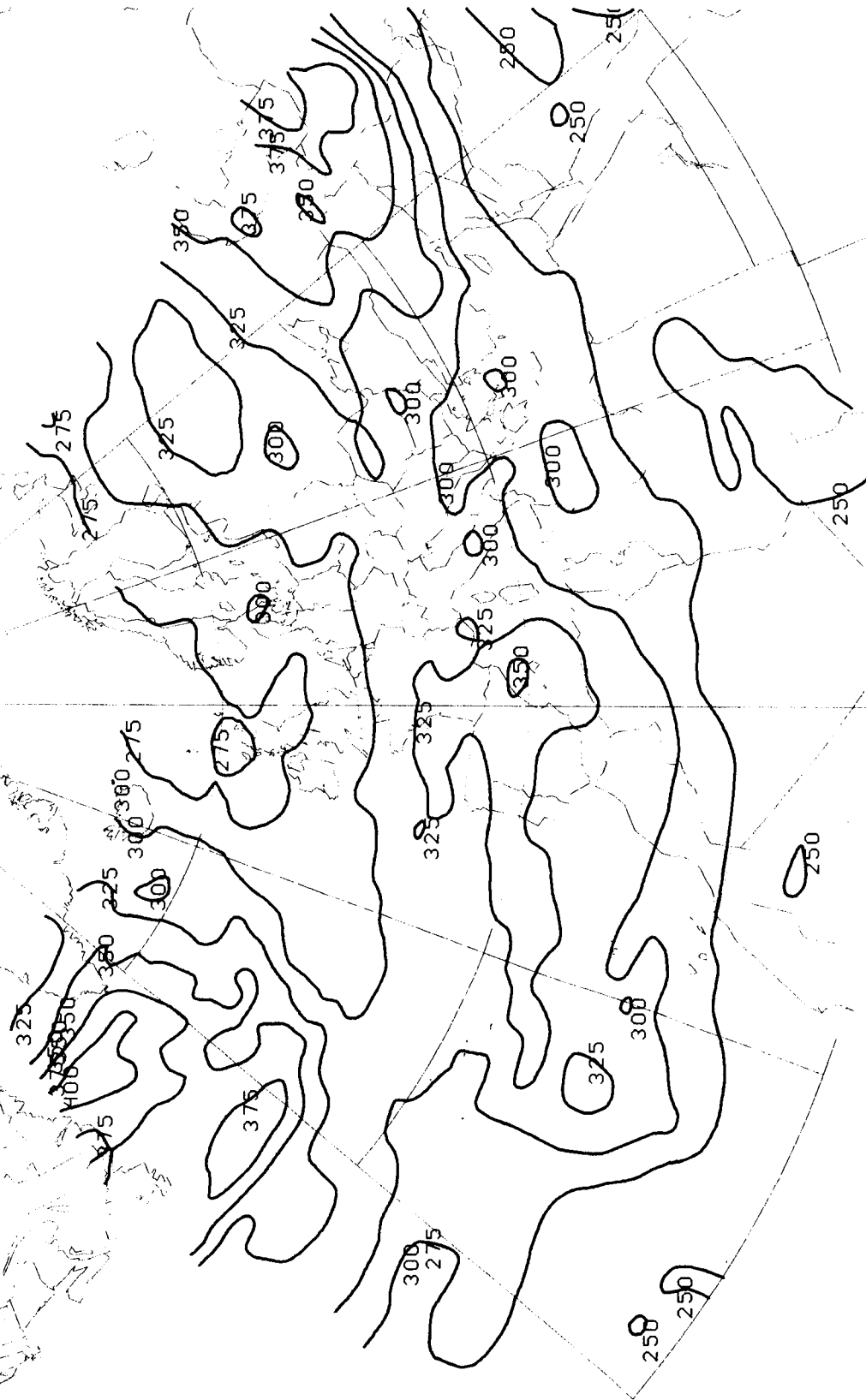
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January 17, 1989

Orbital (51670-51673) TMS Ozone (Dobson units)

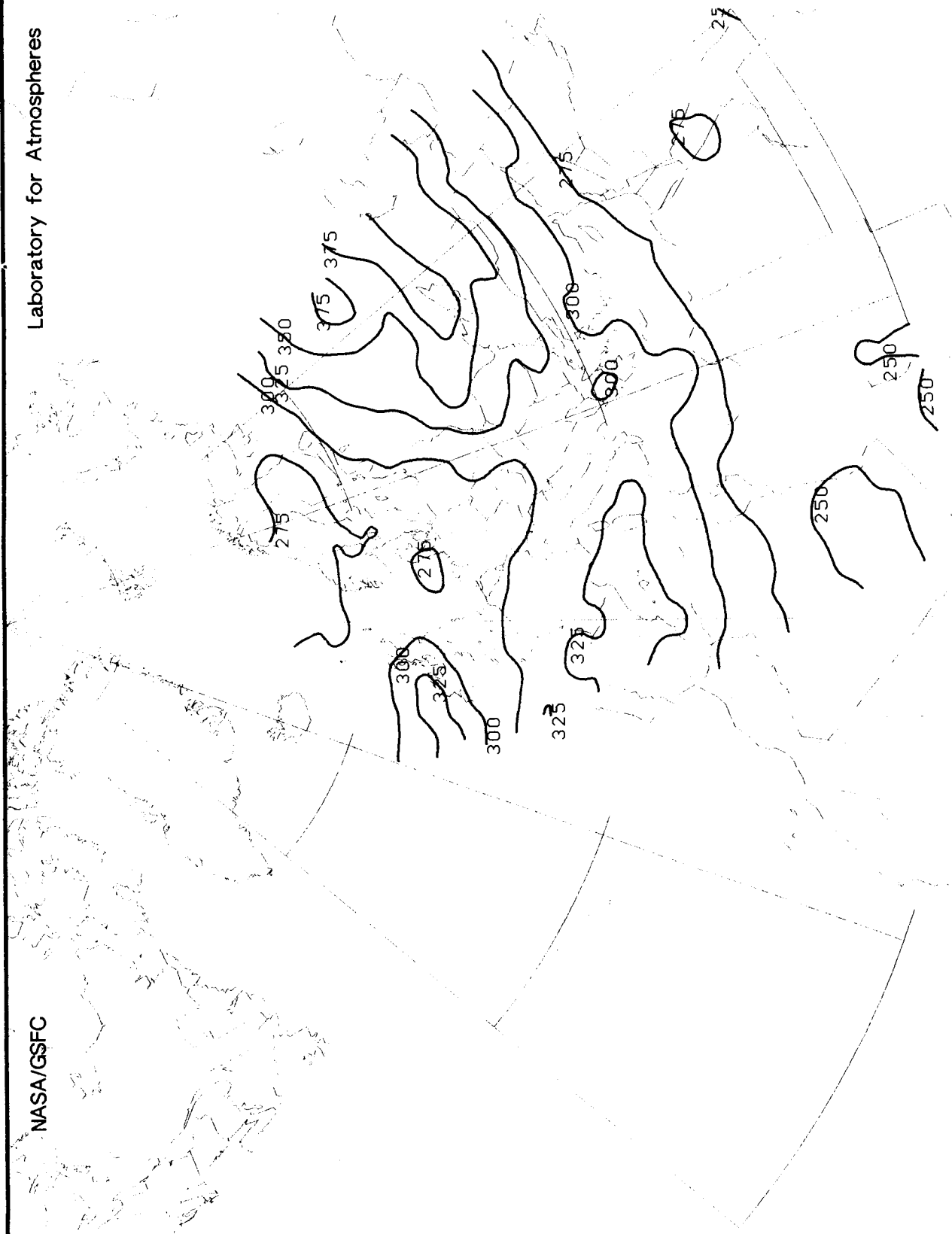


January 18, 1989

Orbital (51684-51687) TOMS Ozone (Dobson units)

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January 19, 1989

Orbital (51698-51700) TOMS Ozone (Dobson units)

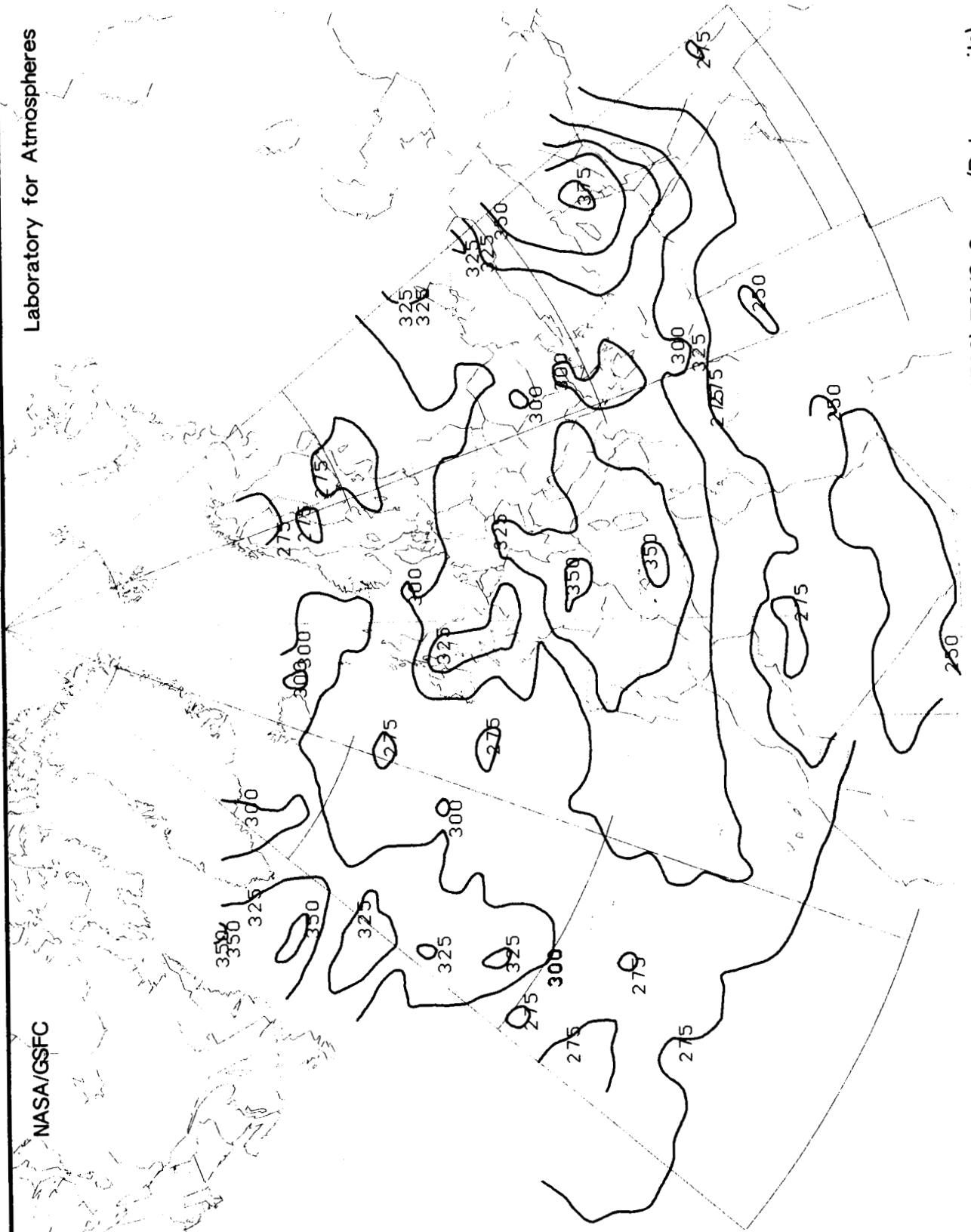


January 20, 1989

Orbital (51712-51714) TOMS Ozone (Dobson units)

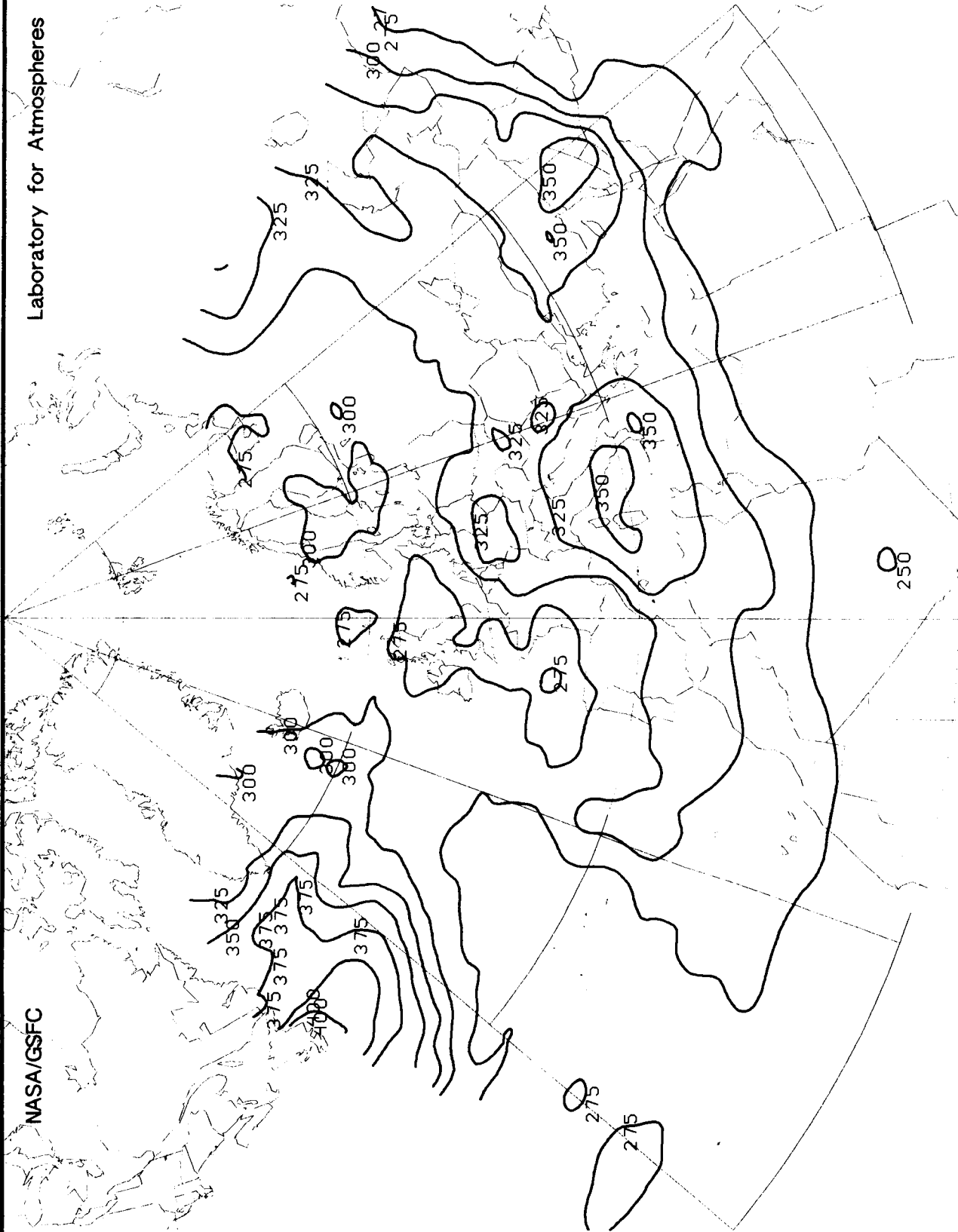
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January 21, 1989

Orbital (51726-51728) TOMS Ozone (Dobson units)

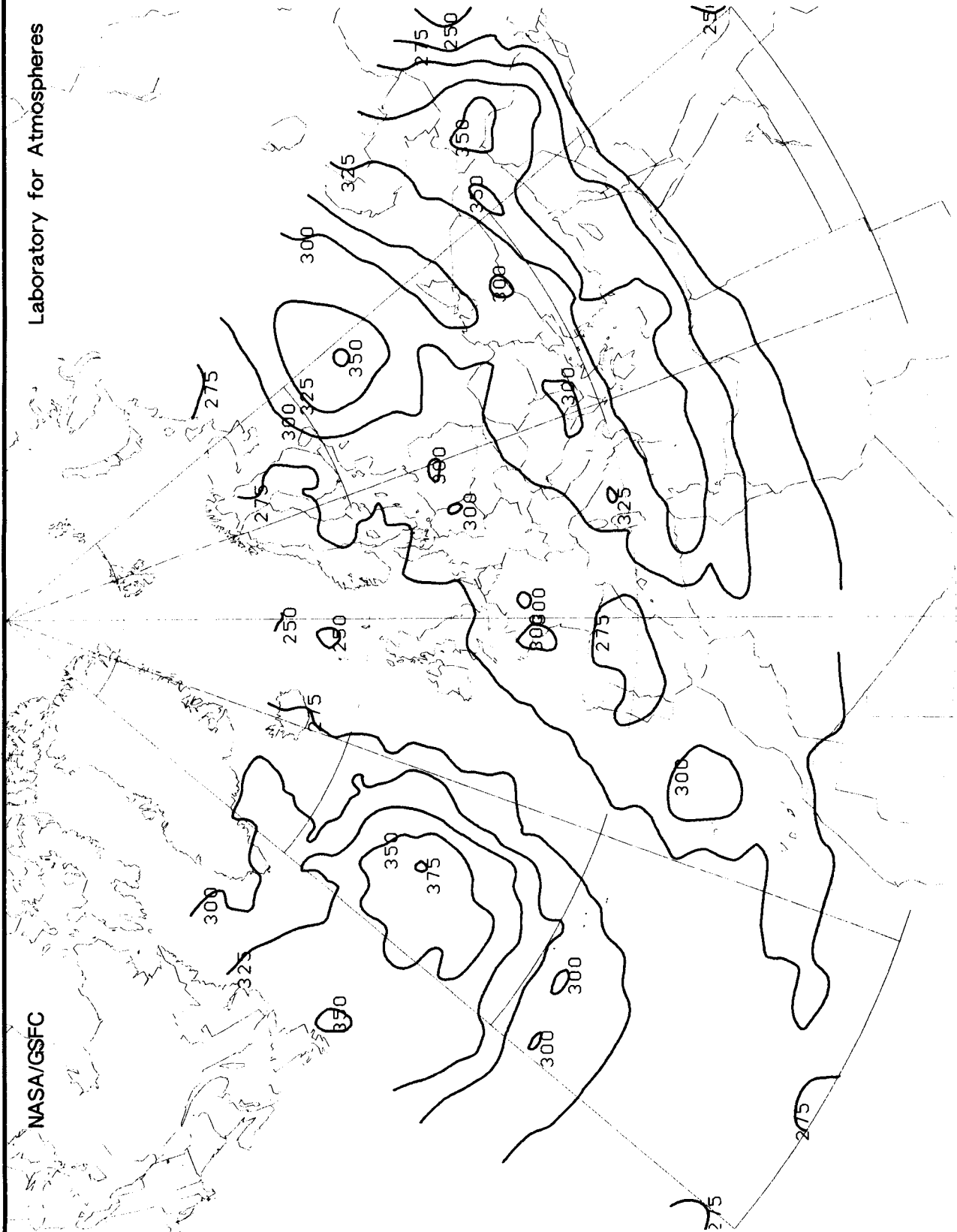


January 22, 1989

Orbital (51739-51743) TOMS Ozone (Dobson units)

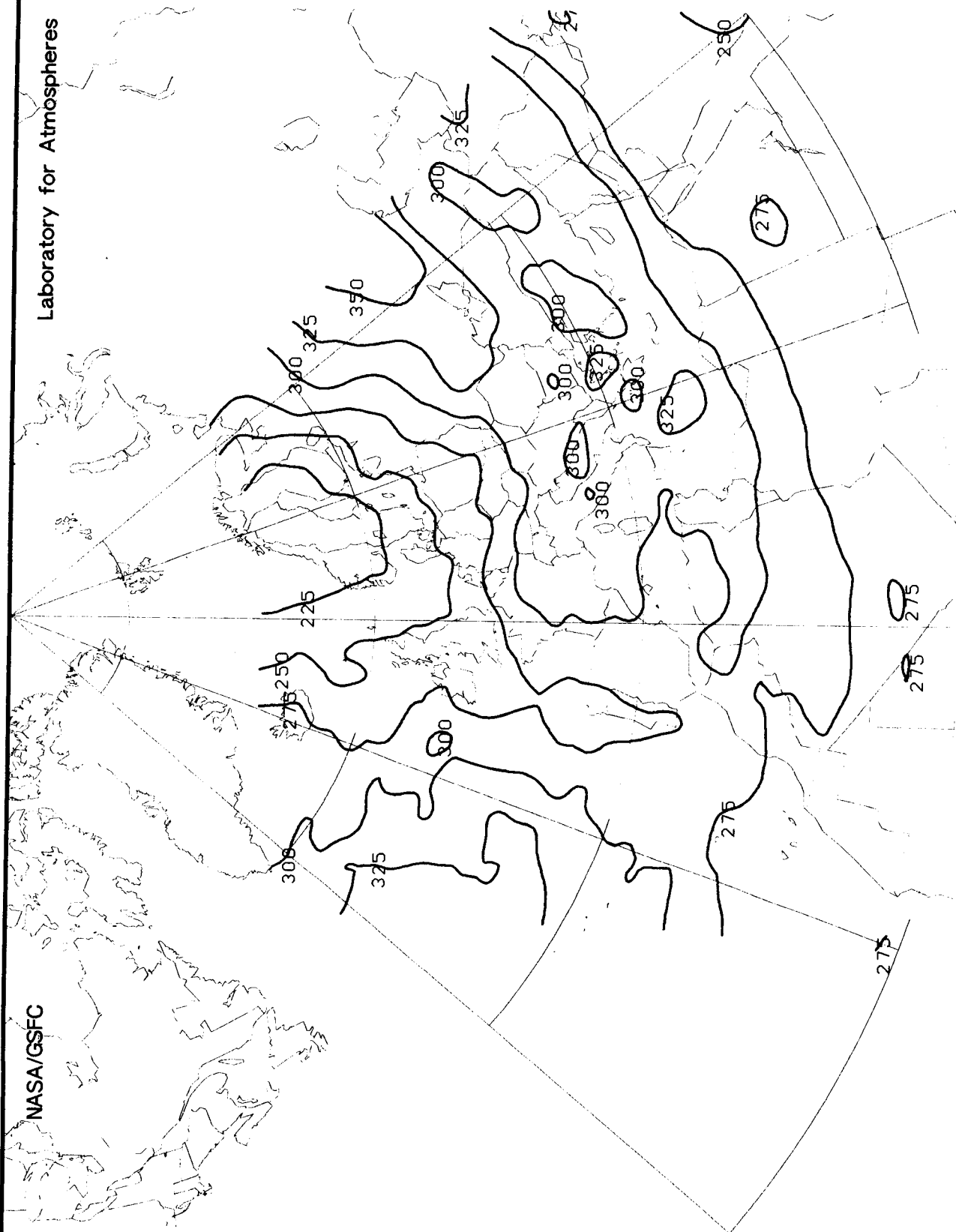
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January 23, 1989

Orbital (51753-51756) TOMS Ozone (Dobson units)

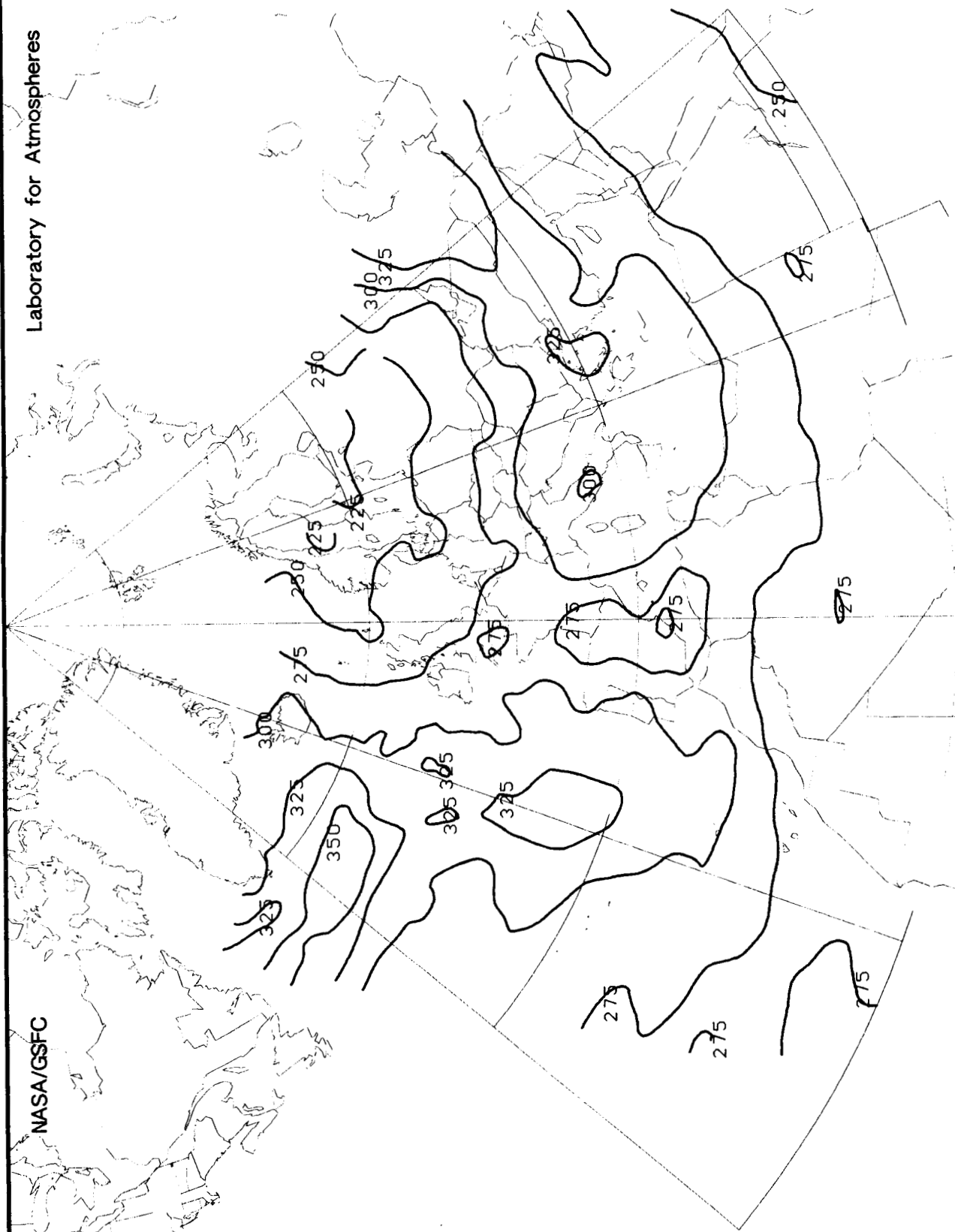


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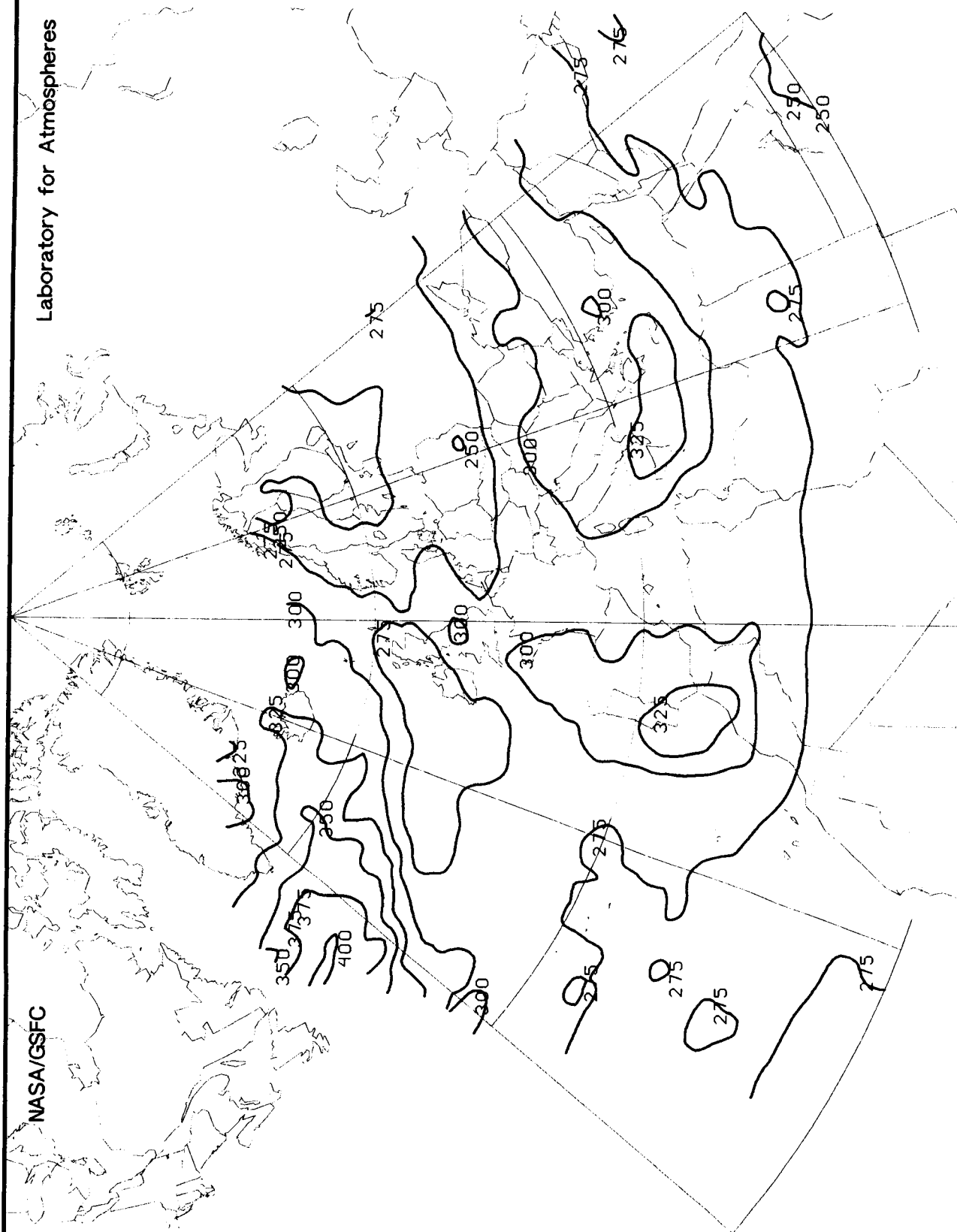
NASA/GSFC

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January 25, 1989

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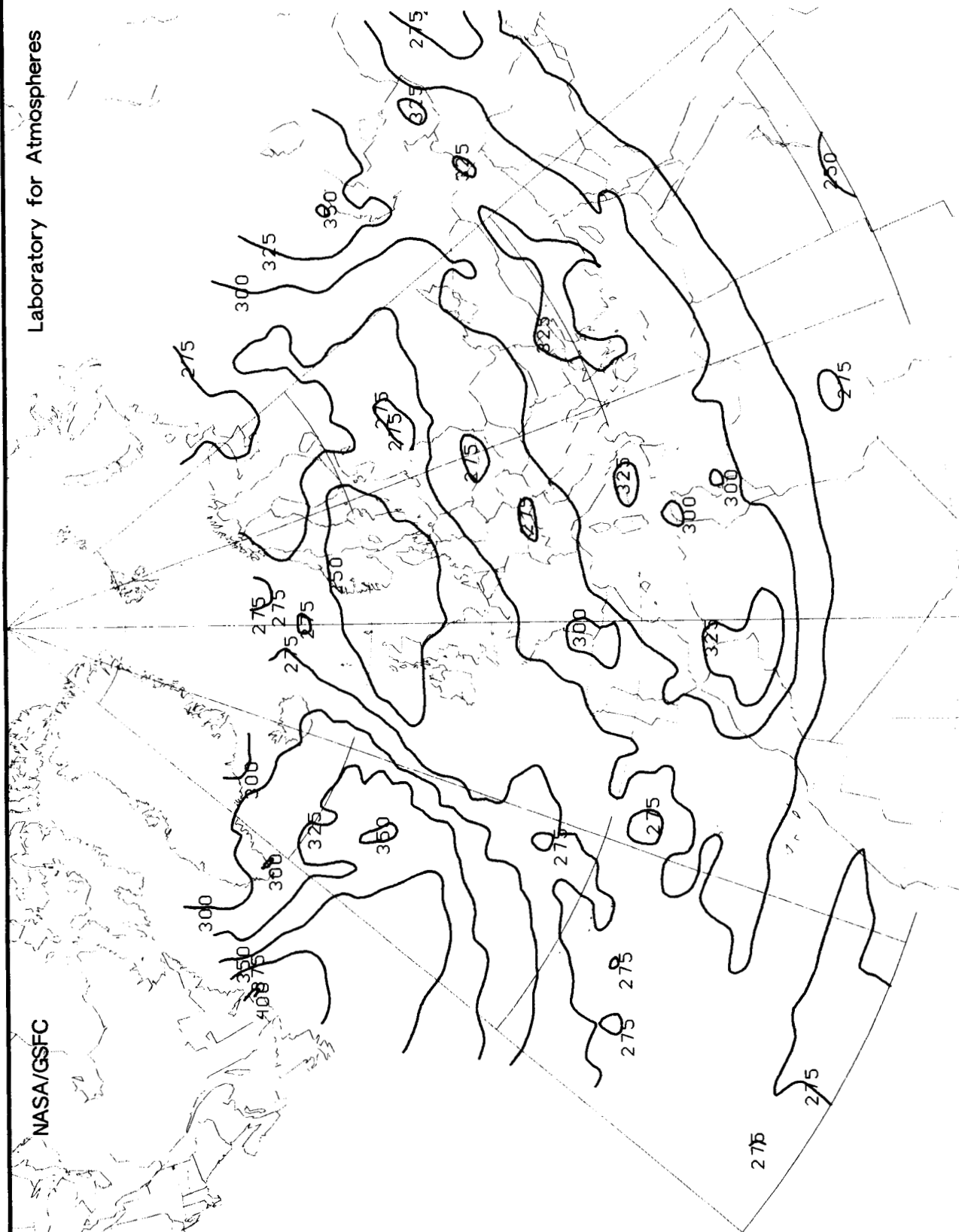


January 26, 1989

Orbital (51795-51797) TOMS Ozone (Dobson units)

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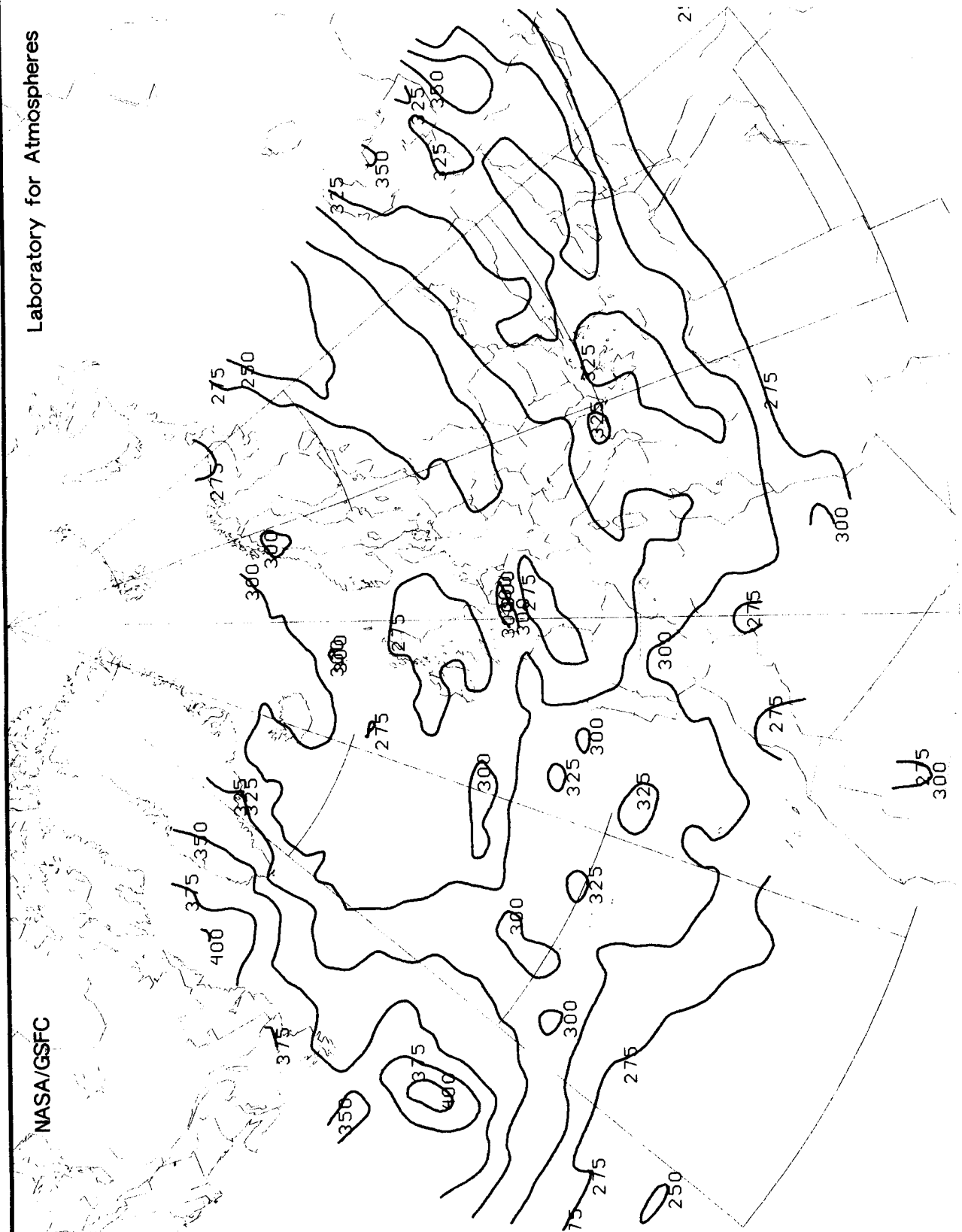
January 27, 1989

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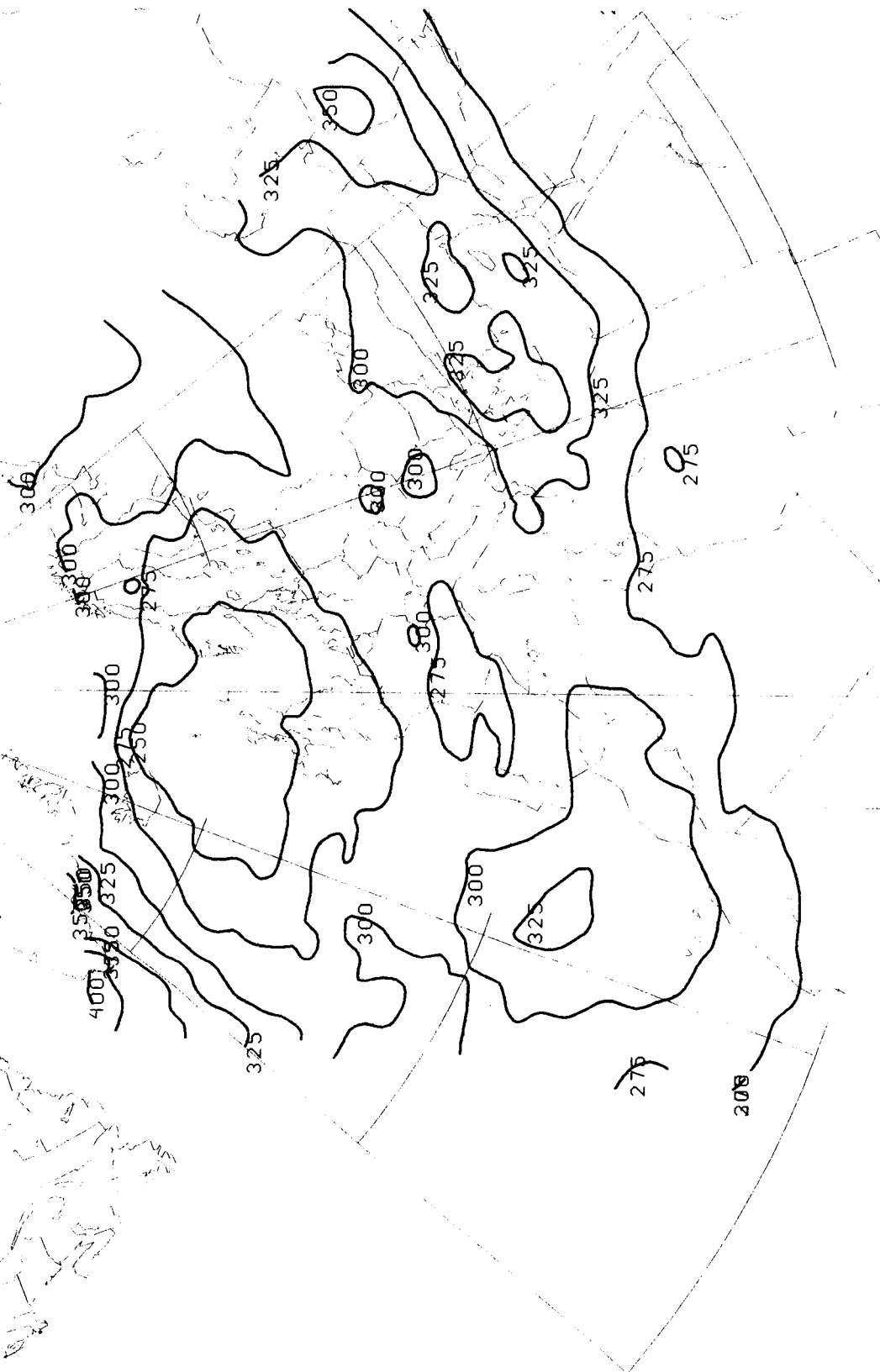
January 28, 1989

Orbital (51822-51825) TOMS Ozone (Dobson units)



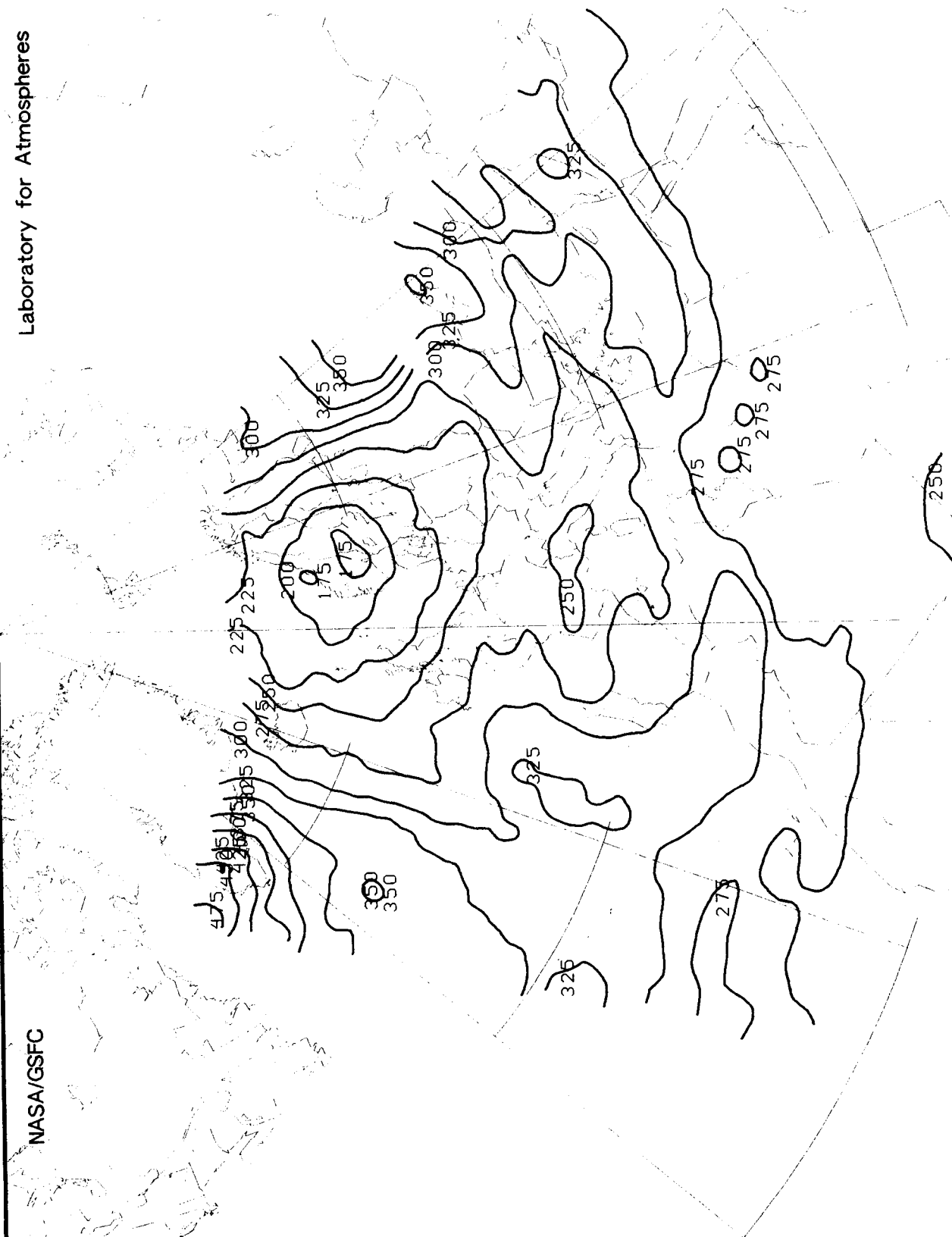
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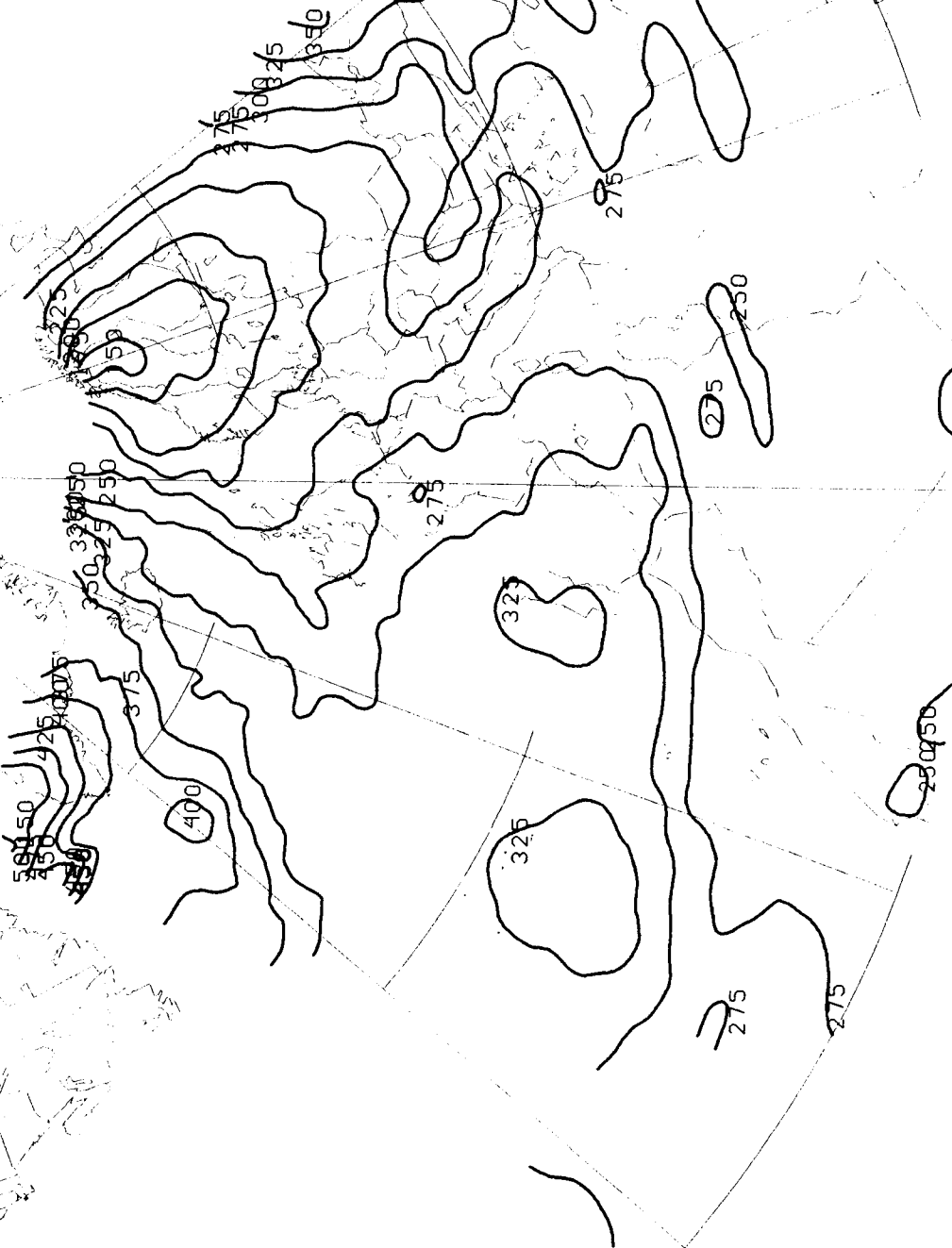
Orbital (51836-51839) TOMS Ozone (Dobson units)



January 30, 1989

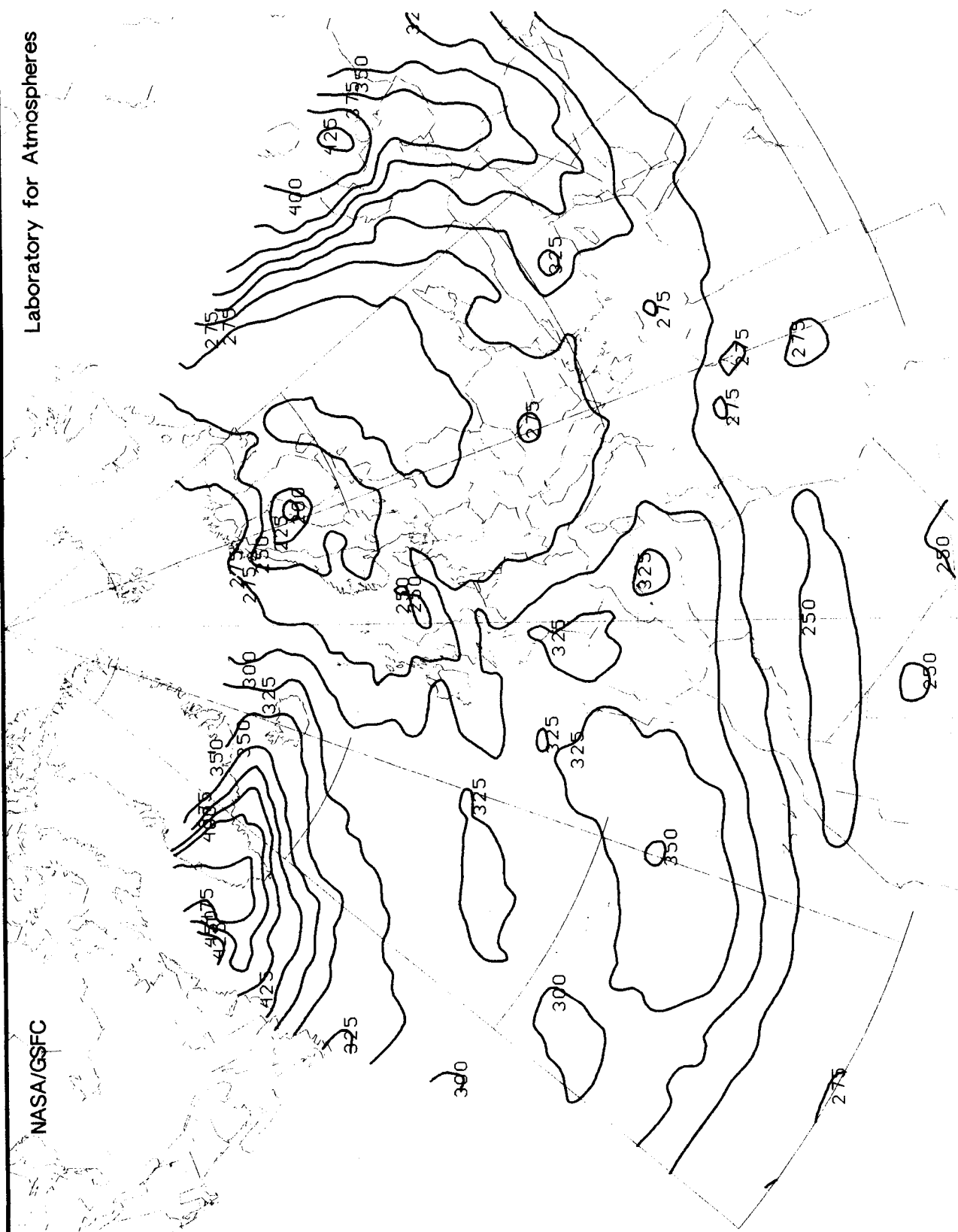
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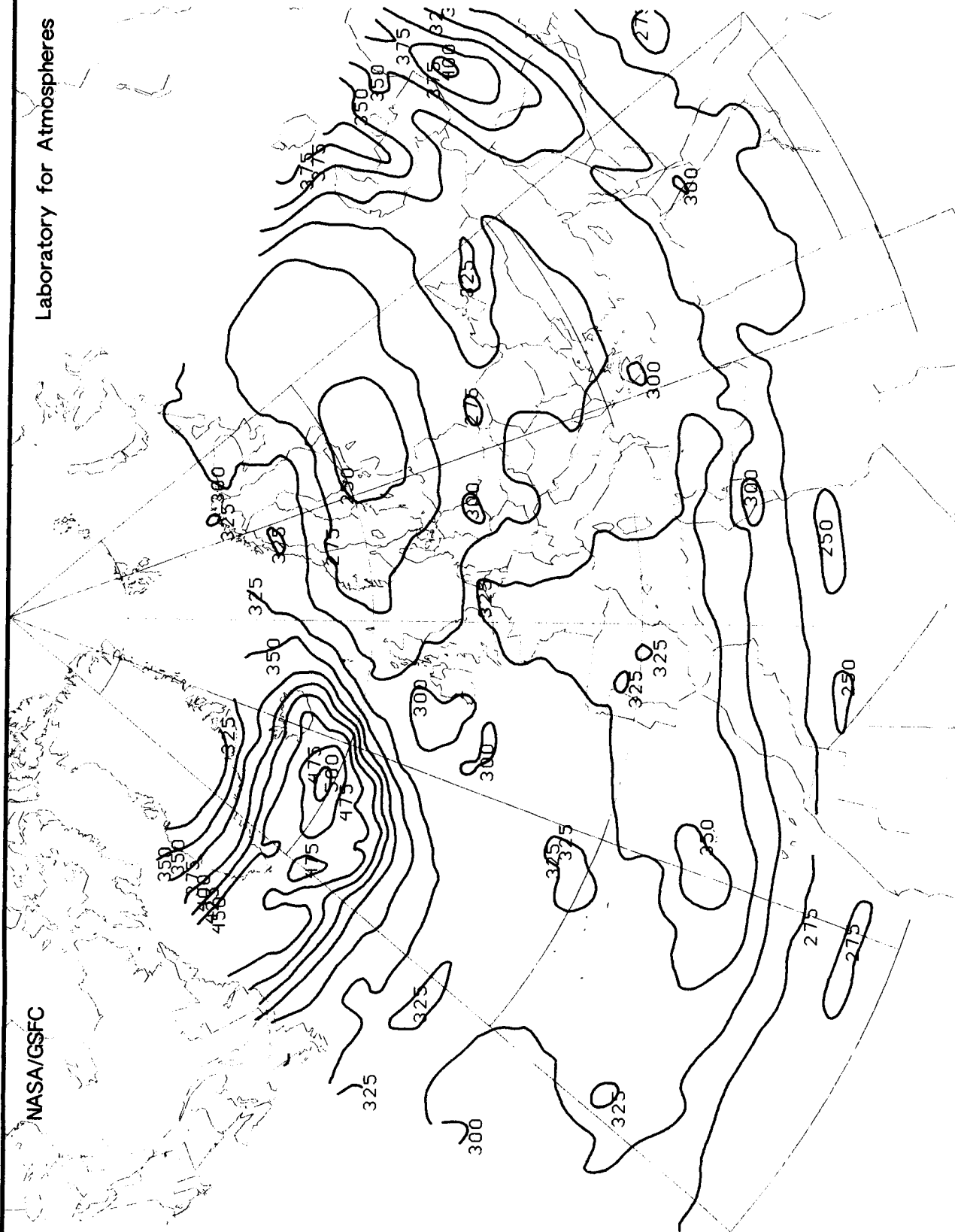




February 1, 1989

Orbital (51878-51880) TOMS Ozone (Dobson units)



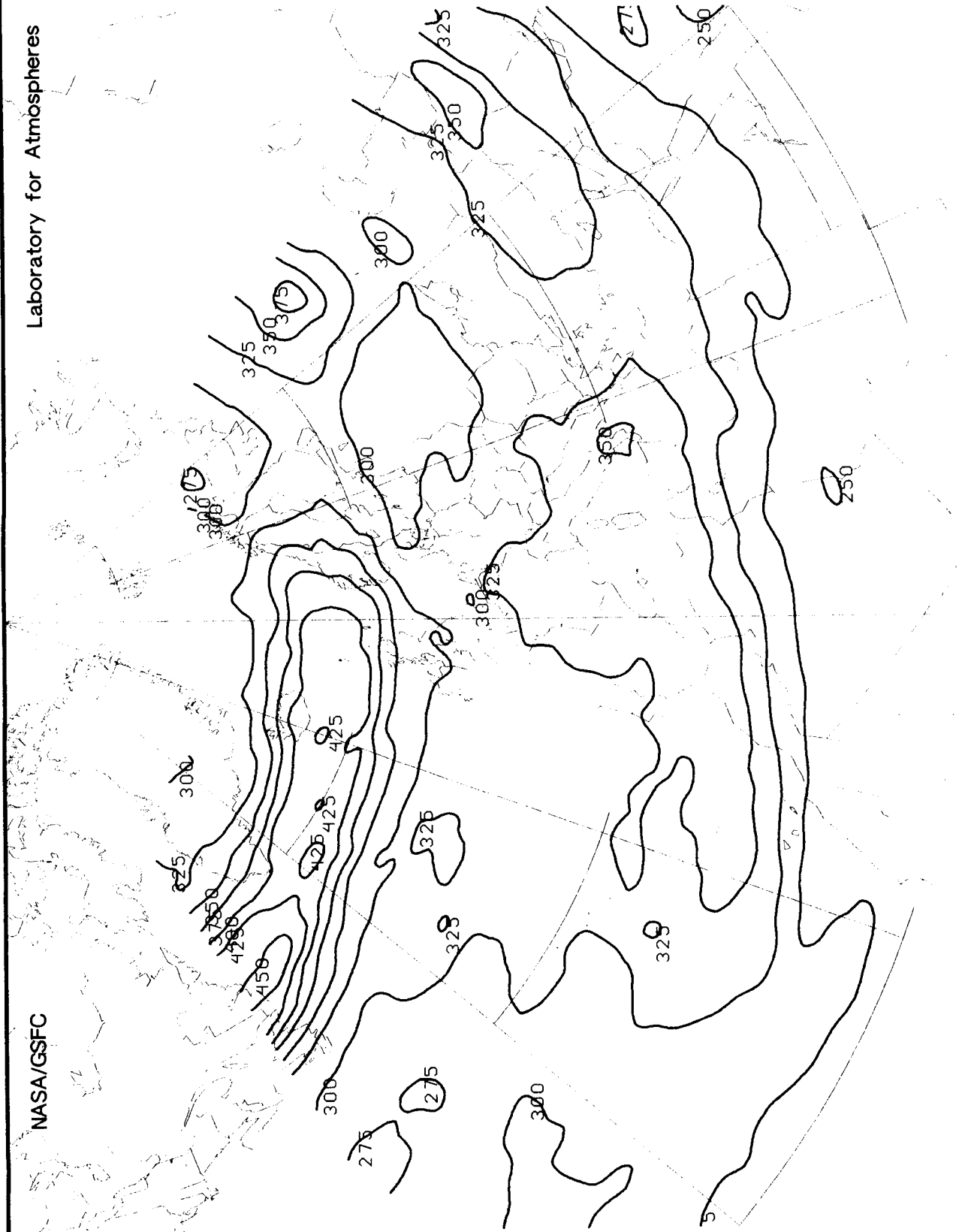


February 3, 1989

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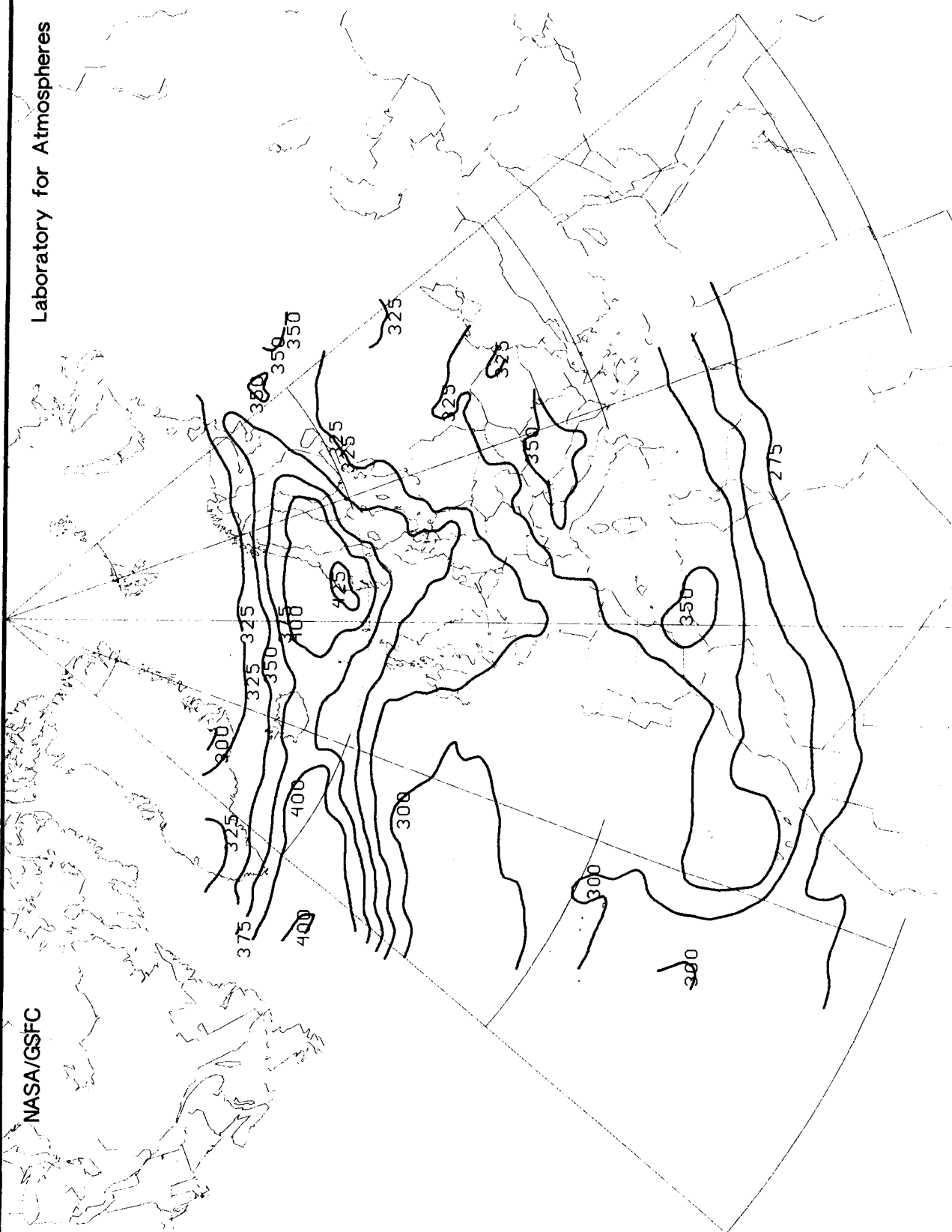
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February 4, 1989

Orbital (51919-51922) TOMS Ozone (Dobson units)

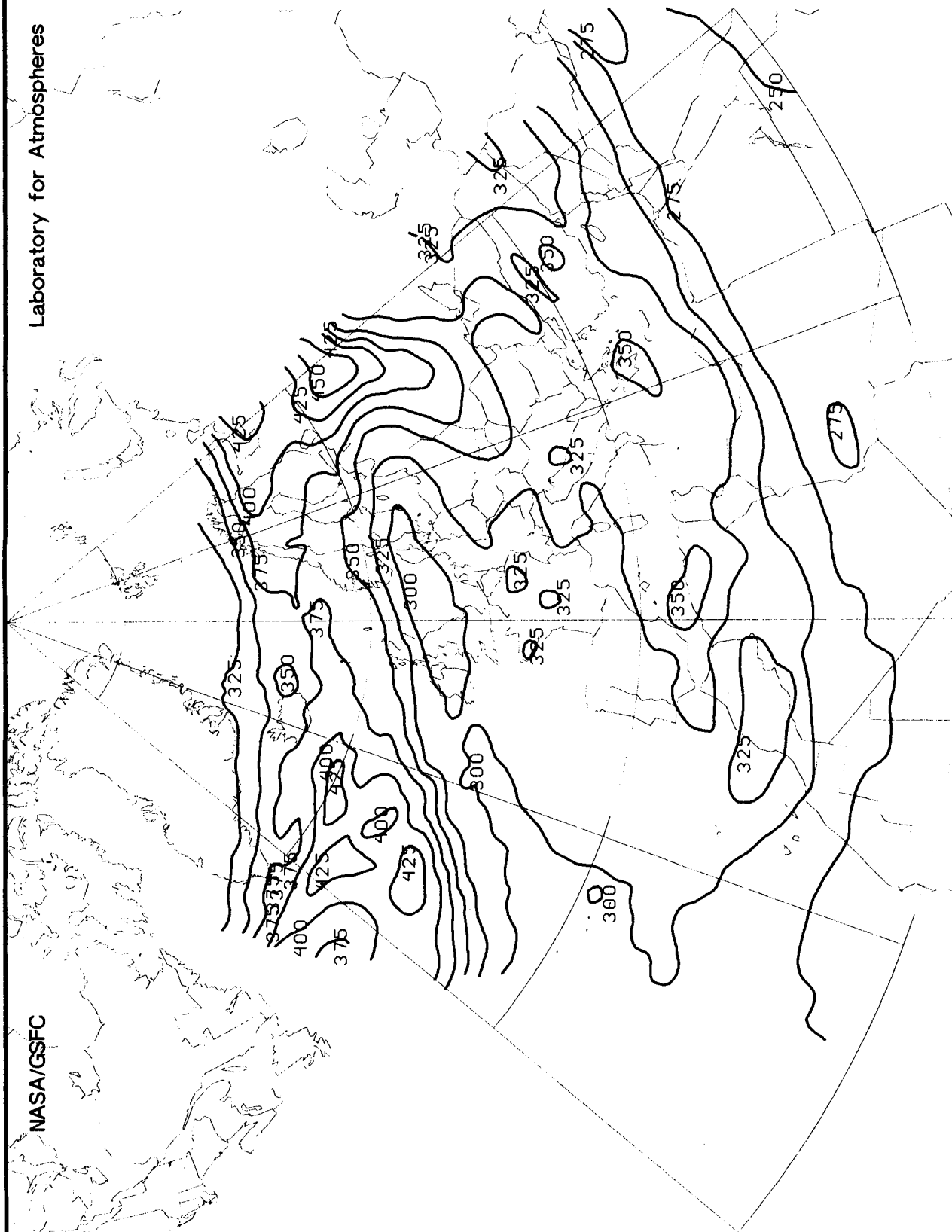


February 5, 1989

Orbital (51933-51935) TMS Ozone (Dobson units)

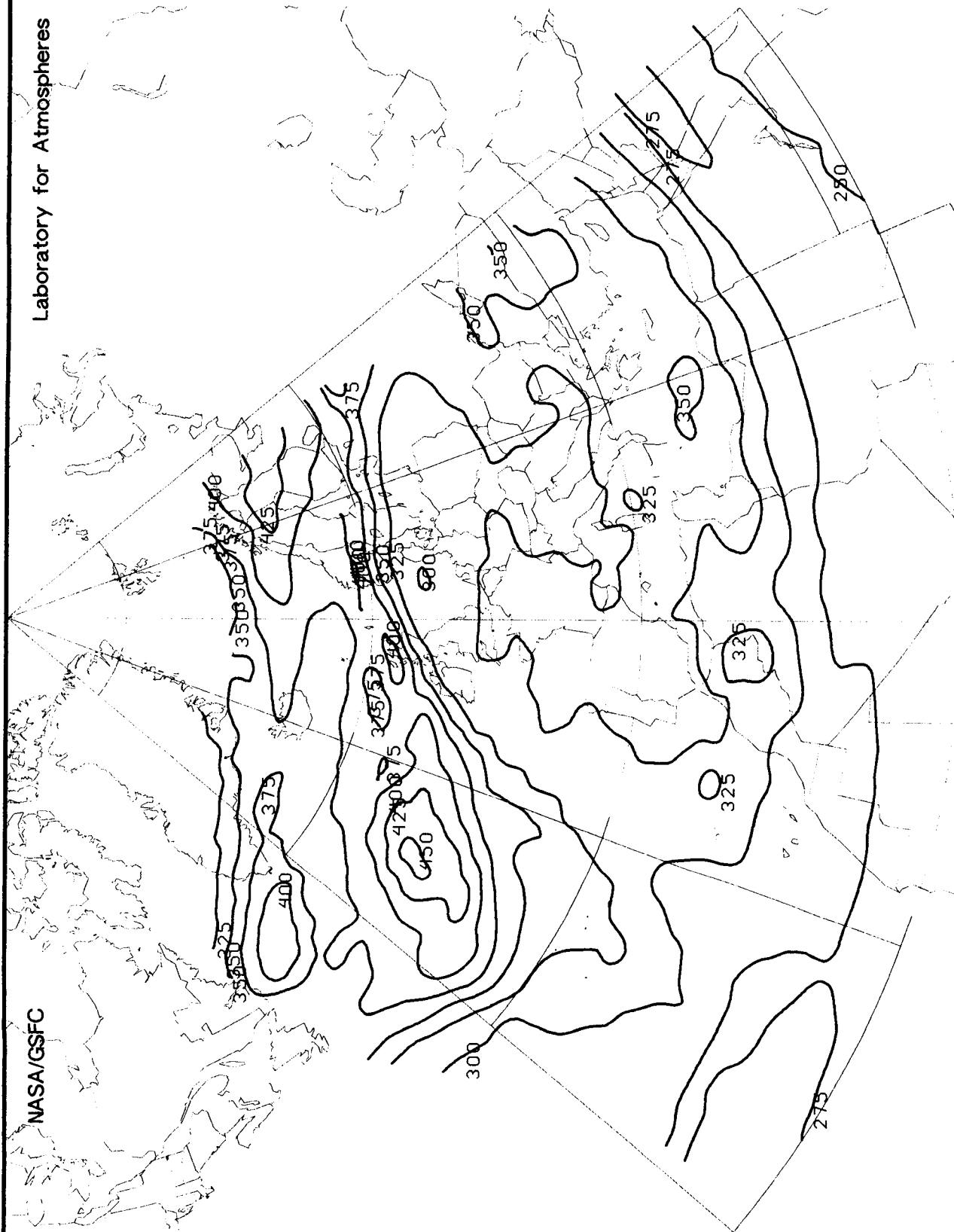
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February 6, 1989

Orbital (51947-51949) TMS Ozone (Dobson units)

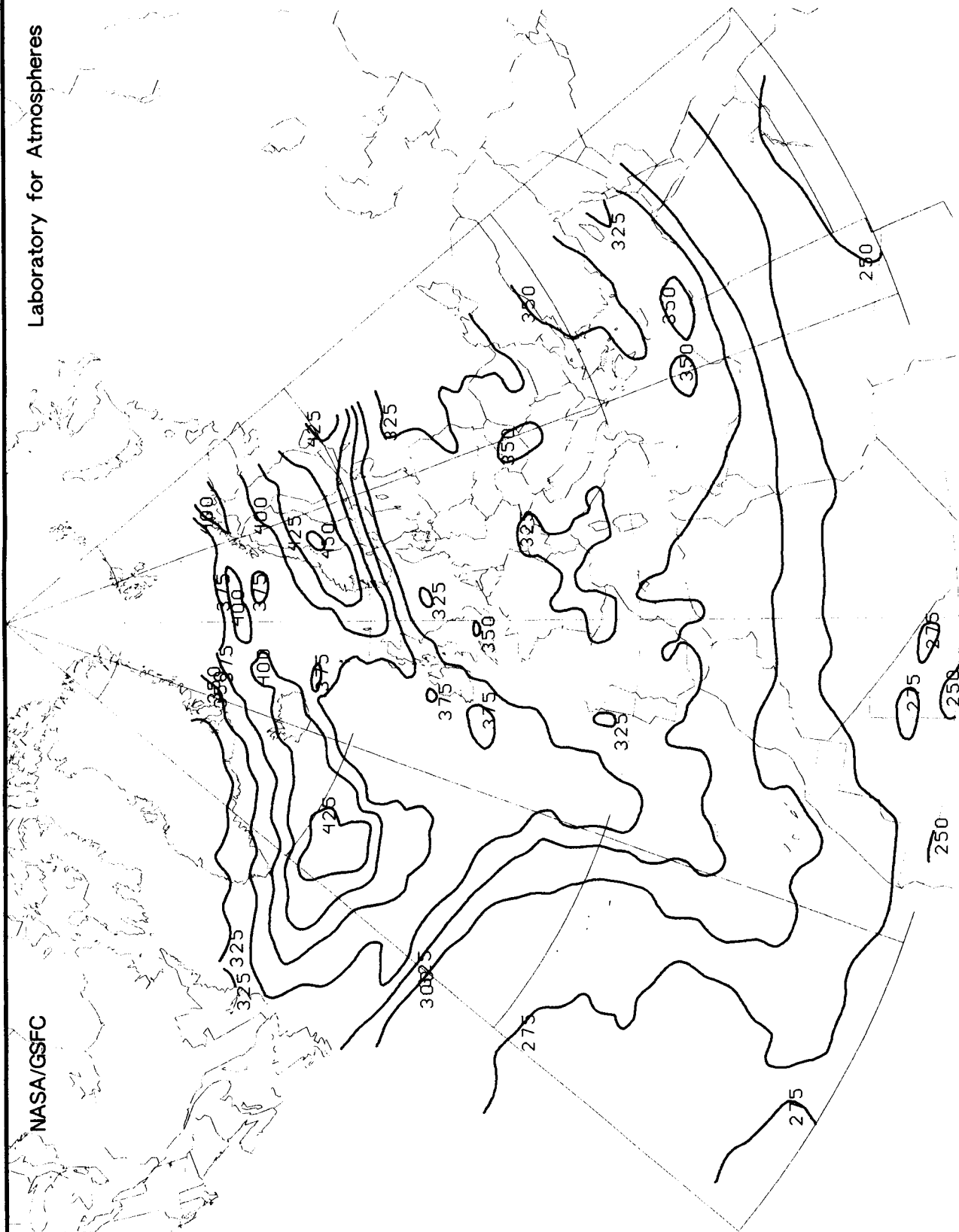


February 7, 1989

Orbital (51961-51963) TMS Ozone (Dobson units)

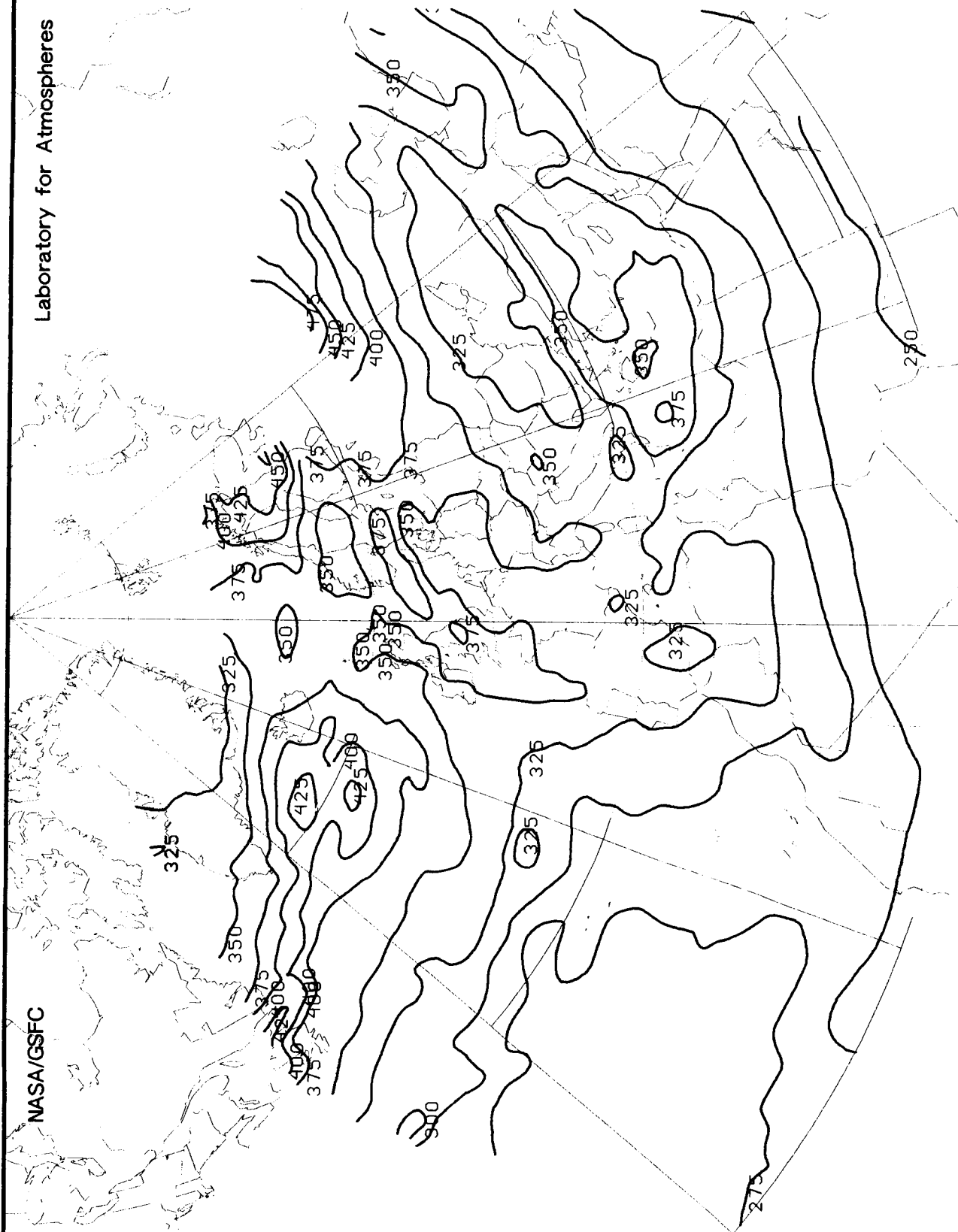
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February 8, 1989

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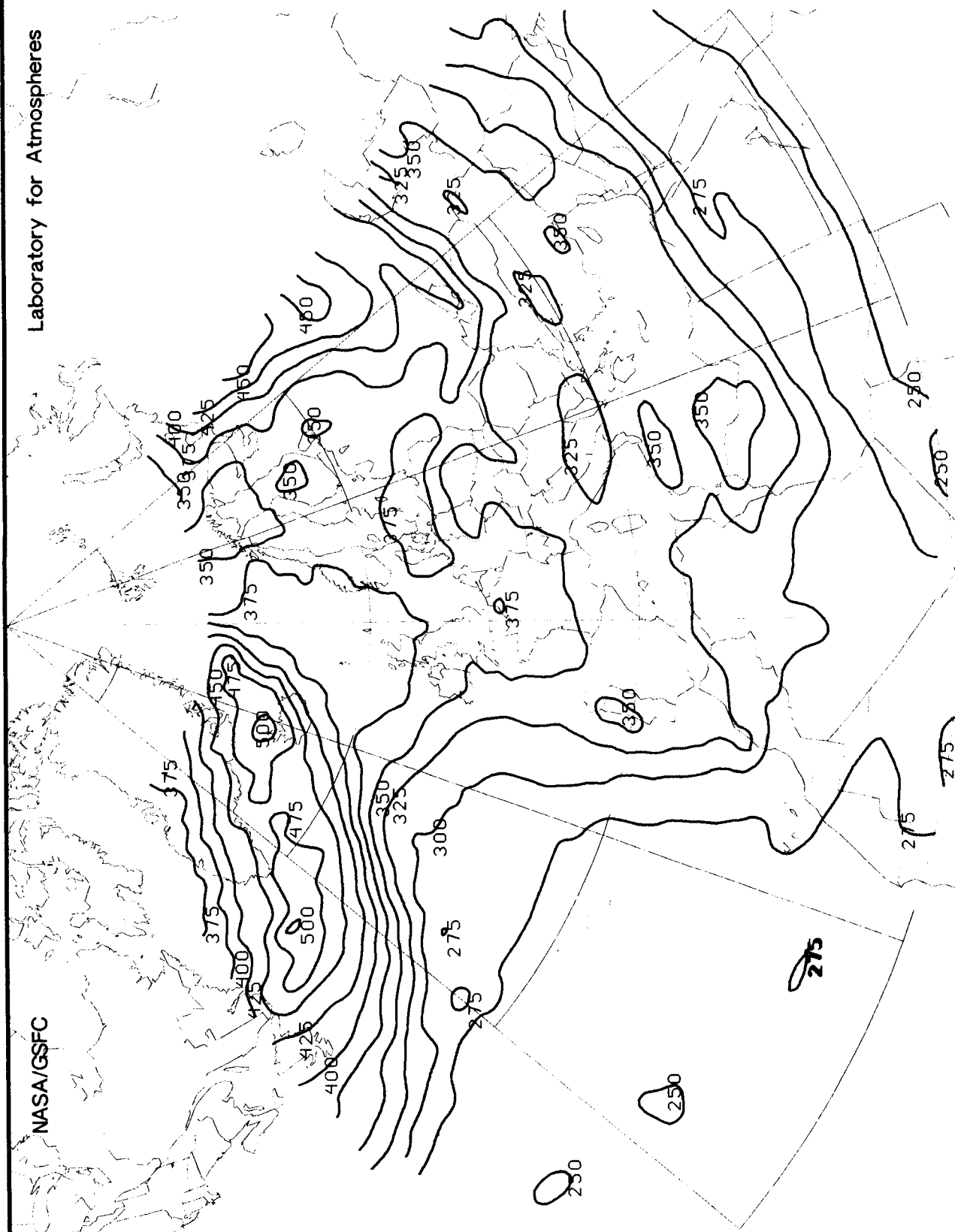


February 9, 1989

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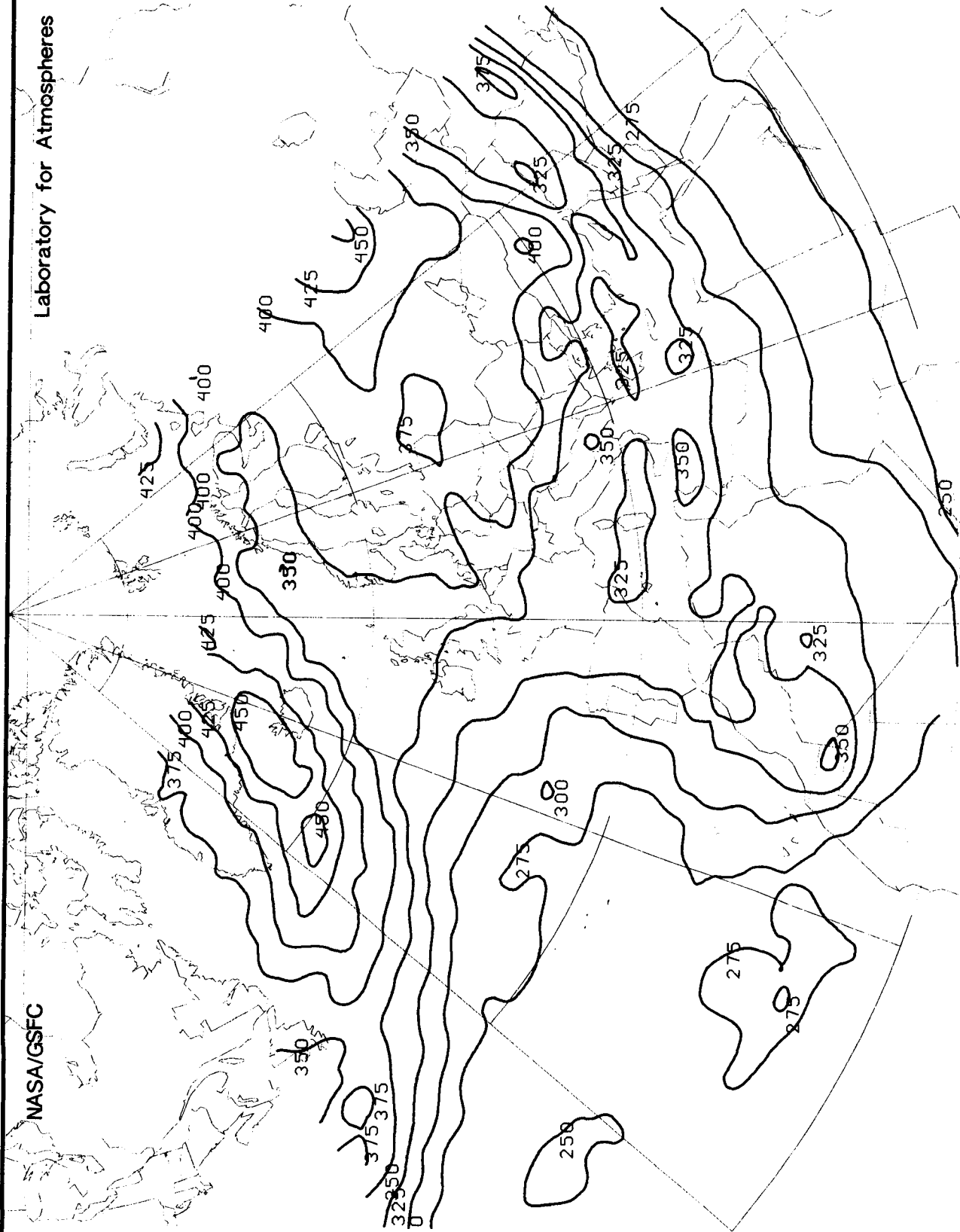
NASA/GSFC

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February 10, 1989

Orbital (52002-52004) TOMS Ozone (Dobson units)

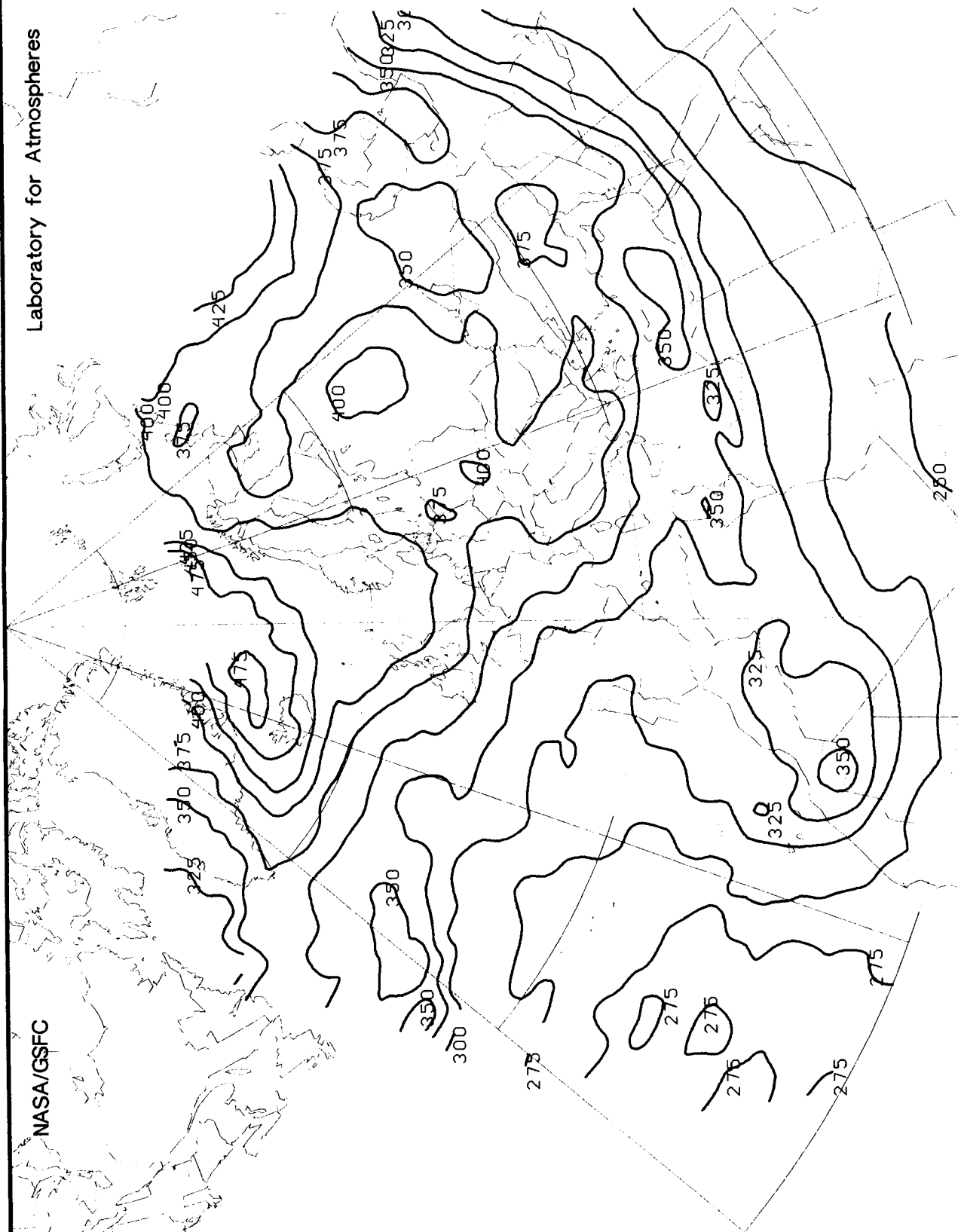


February 11, 1989

Orbital (52016-52020) TMS Ozone (Dobson units)

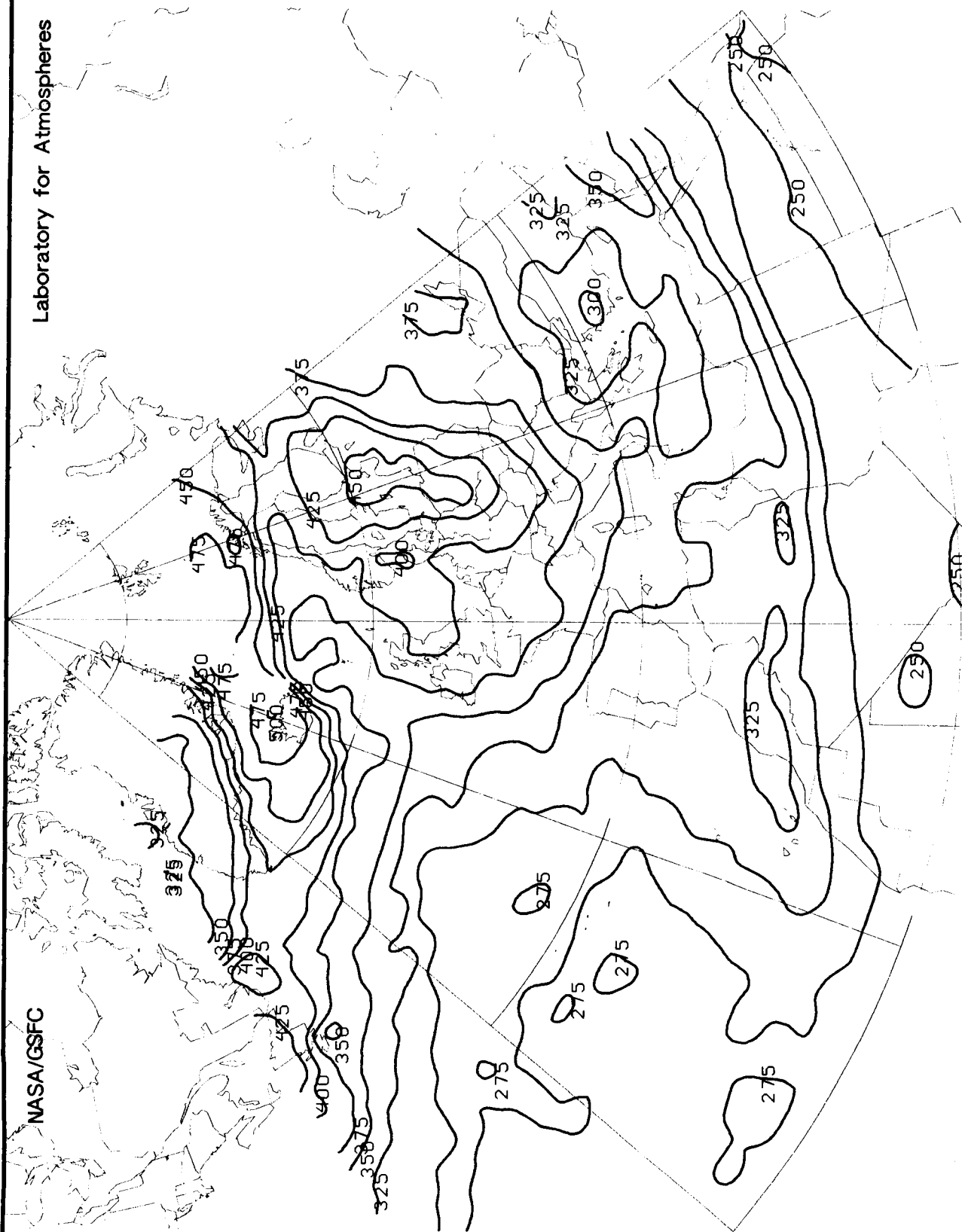
NASA/GSFC

Laboratory for Atmospheres



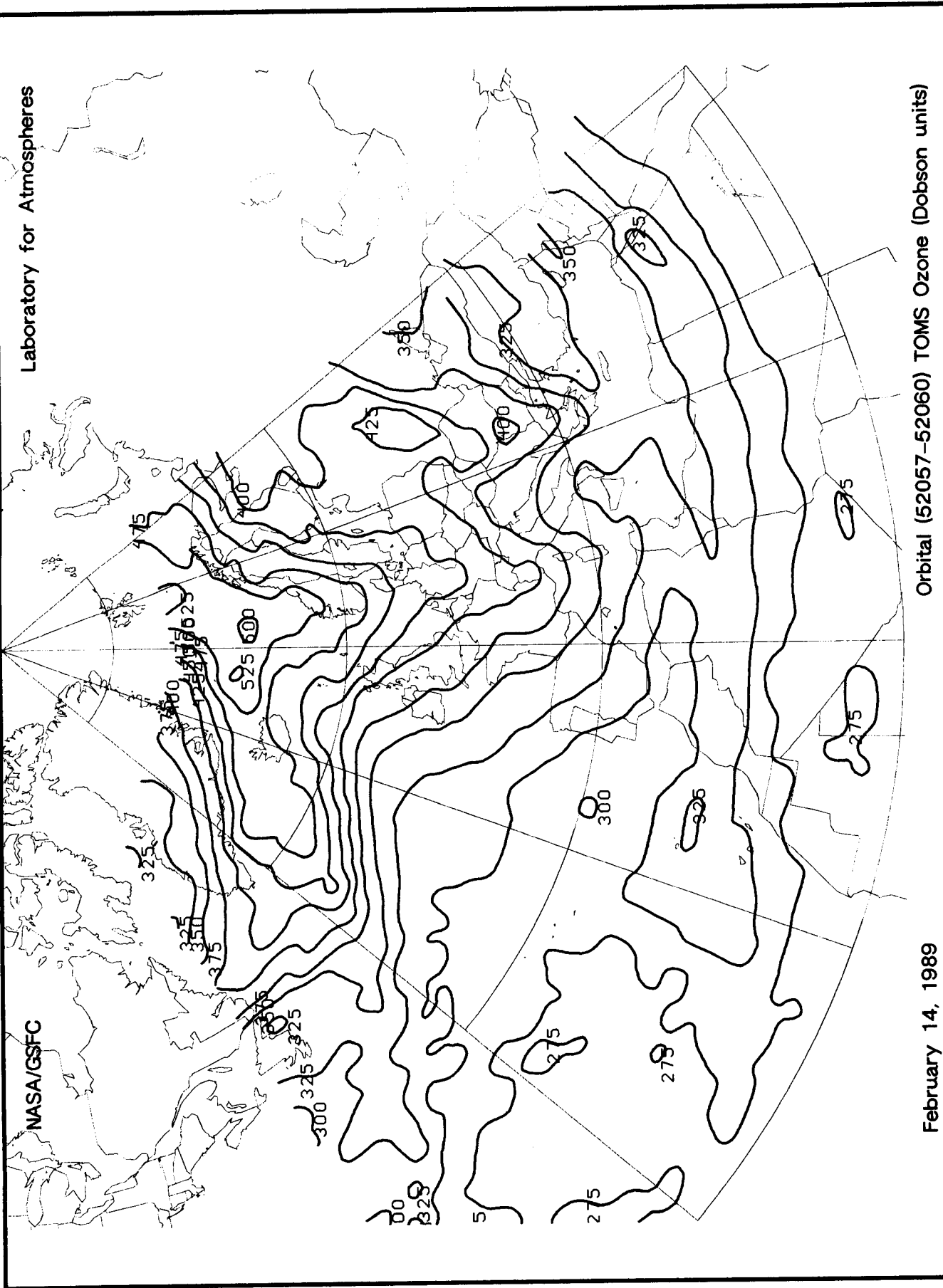
February 12, 1989

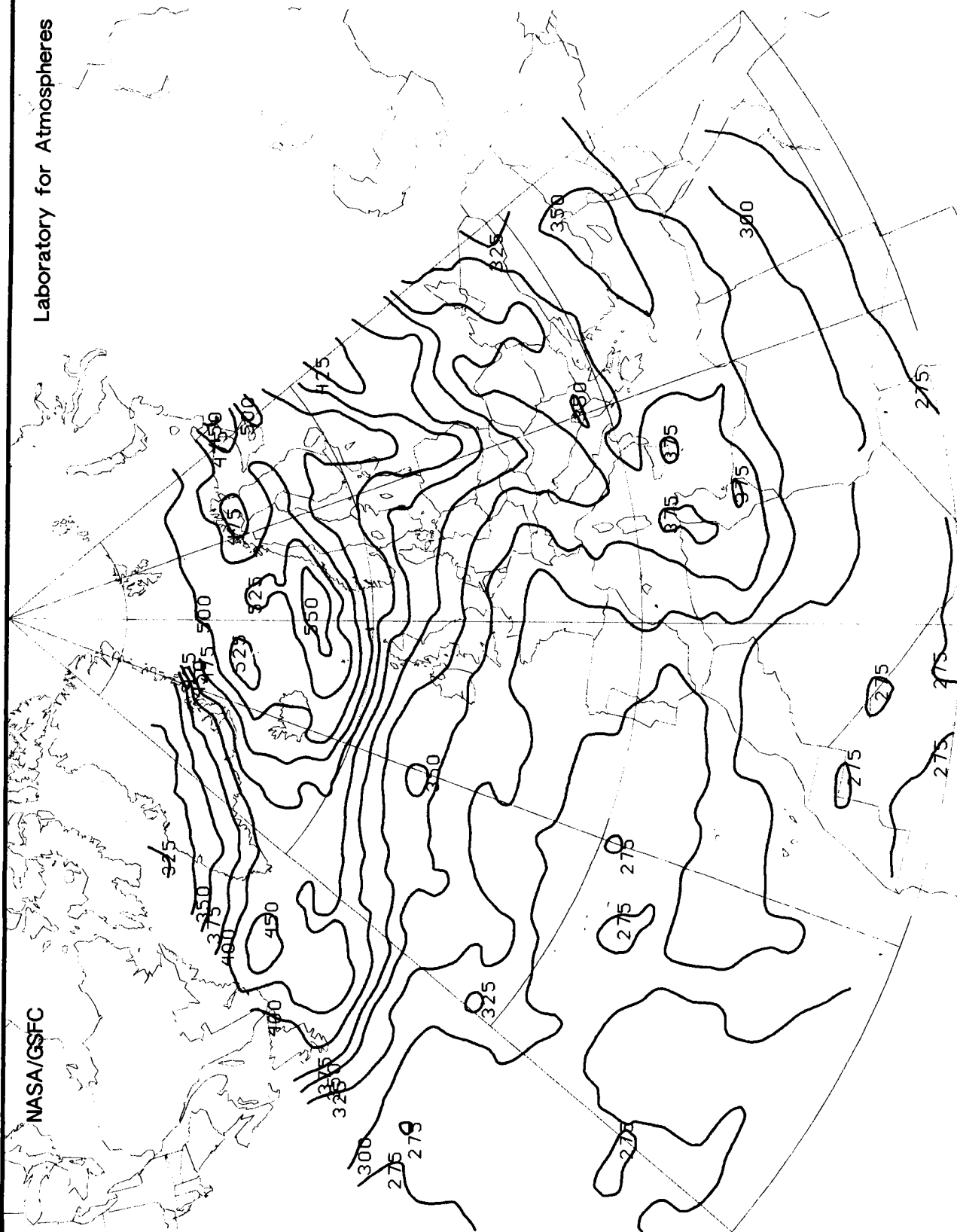
Orbital (52029-52032) TOMS Ozone (Dobson units)



February 13, 1989

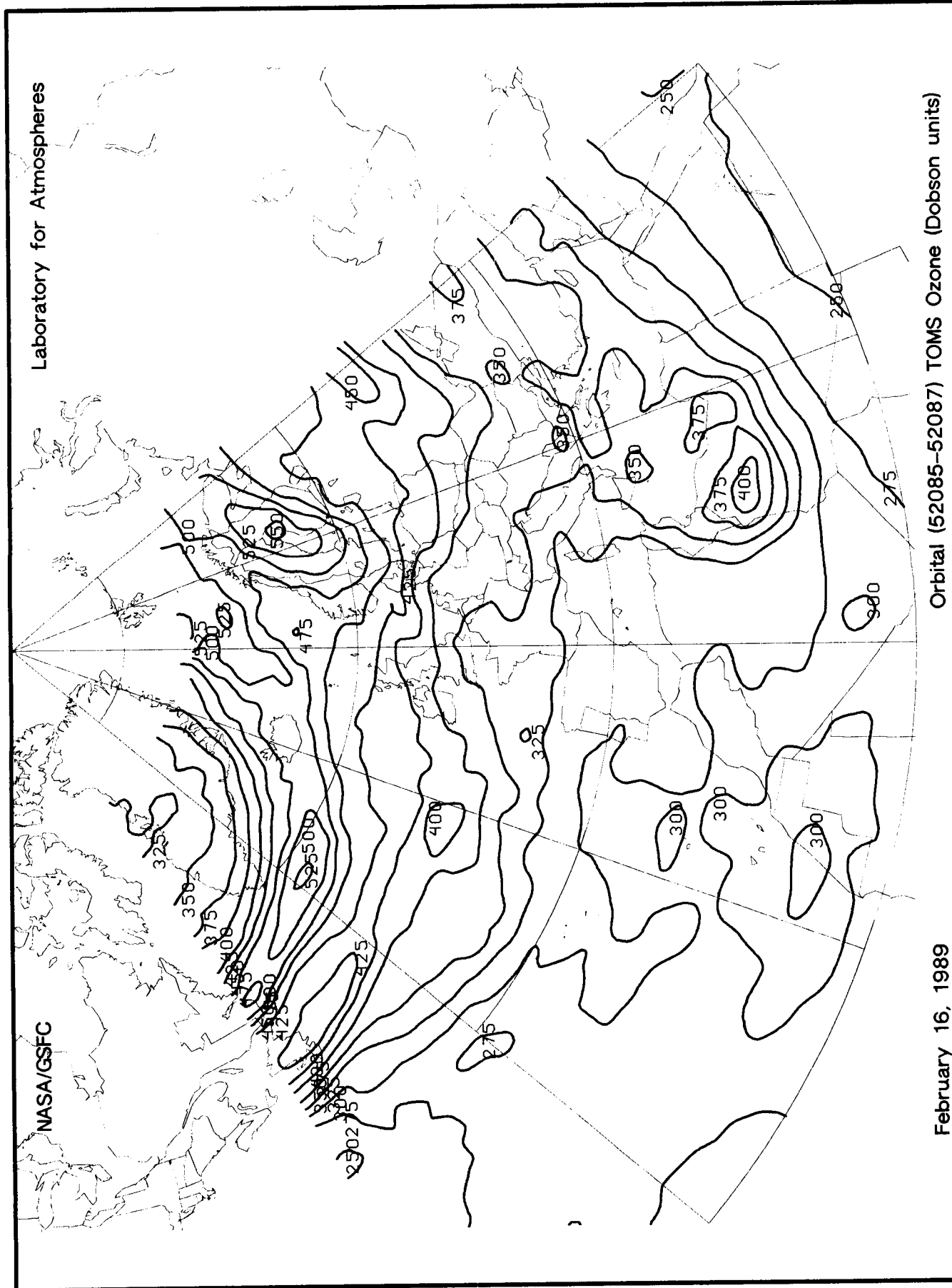
Orbital (52044-52046) TOMS Ozone (Dobson units)





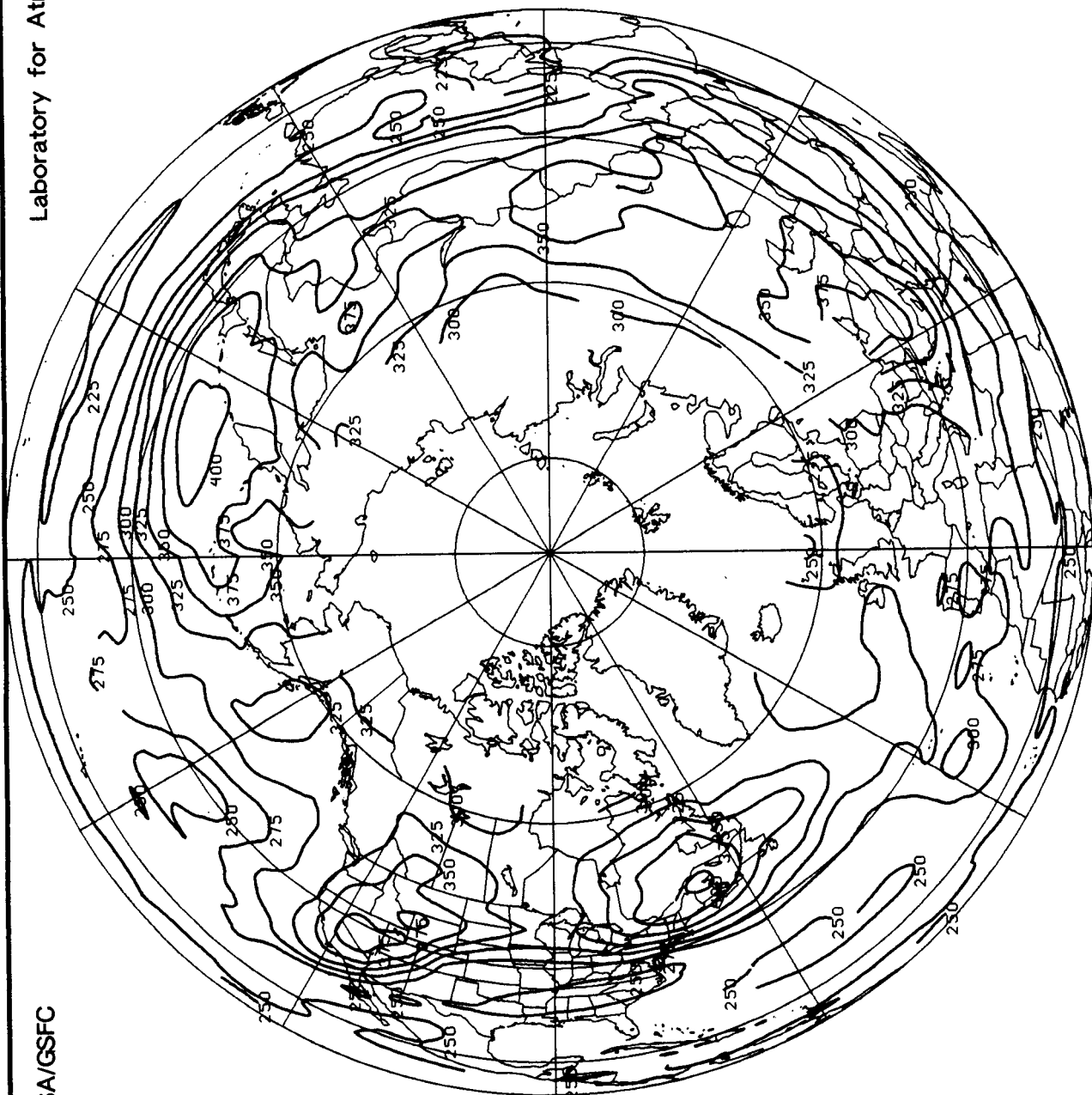
February 15, 1989

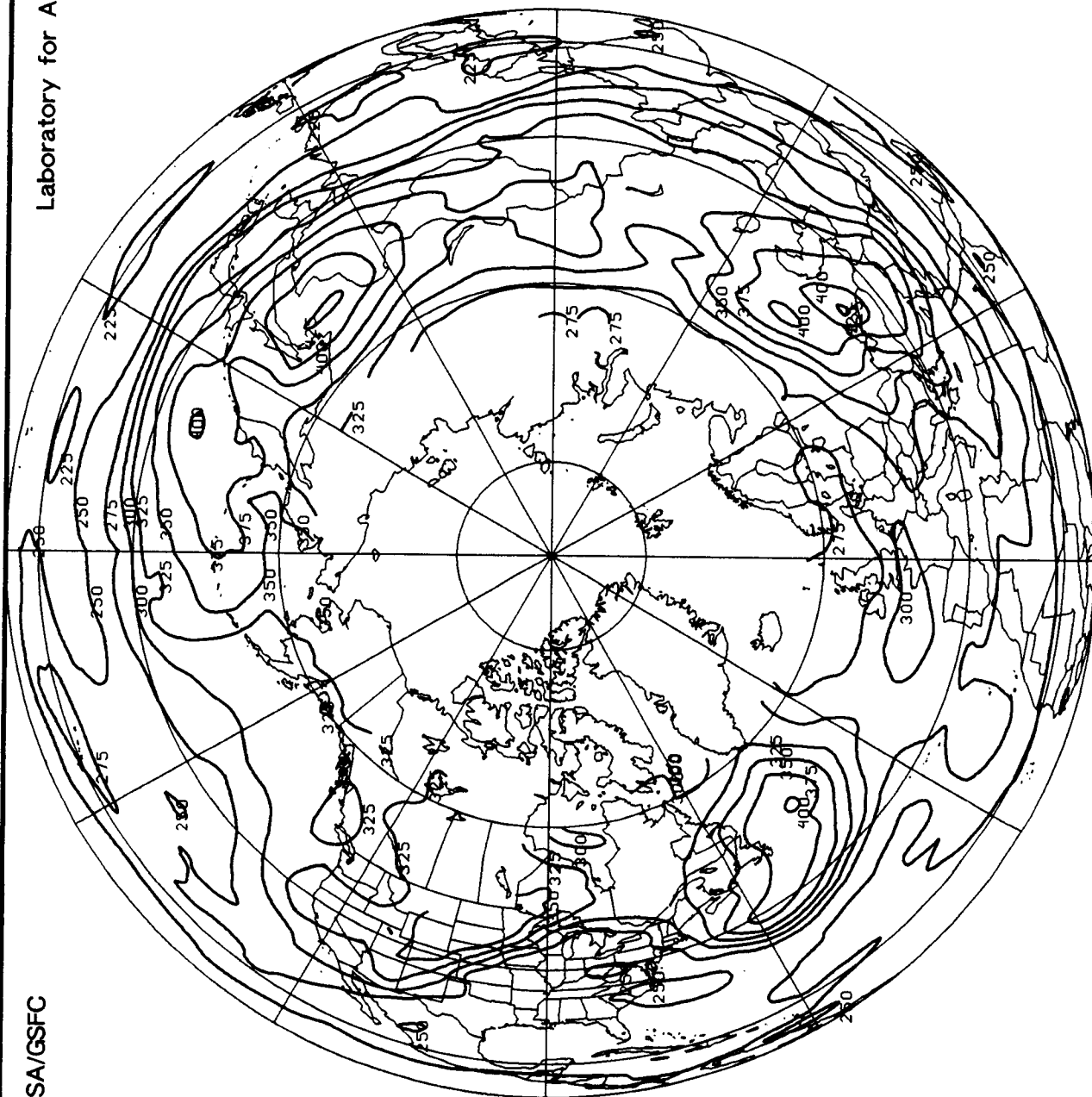
Orbital (52071-52074) TOMS Ozone (Dobson units)



3.3 Northern Hemisphere Polar Charts

A set of TOMS total ozone maps for the northern hemisphere, over the period December 26, 1988 through March 20, 1989 is presented here. The daily data are resolved on a uniform 2° latitude by 5° longitude grid for each day, and displayed using a north-polar orthographic projection.



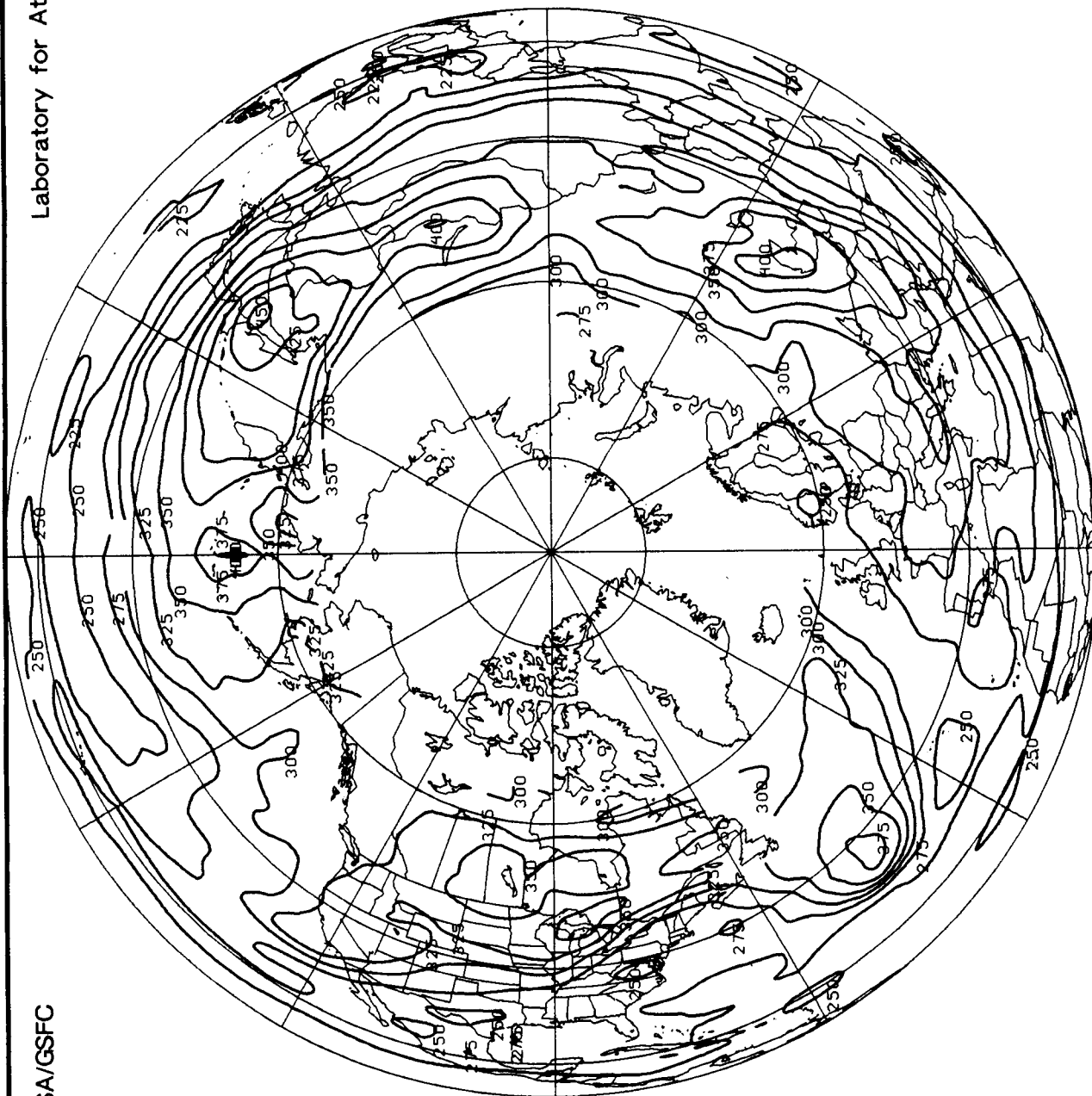


December 27, 1988

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

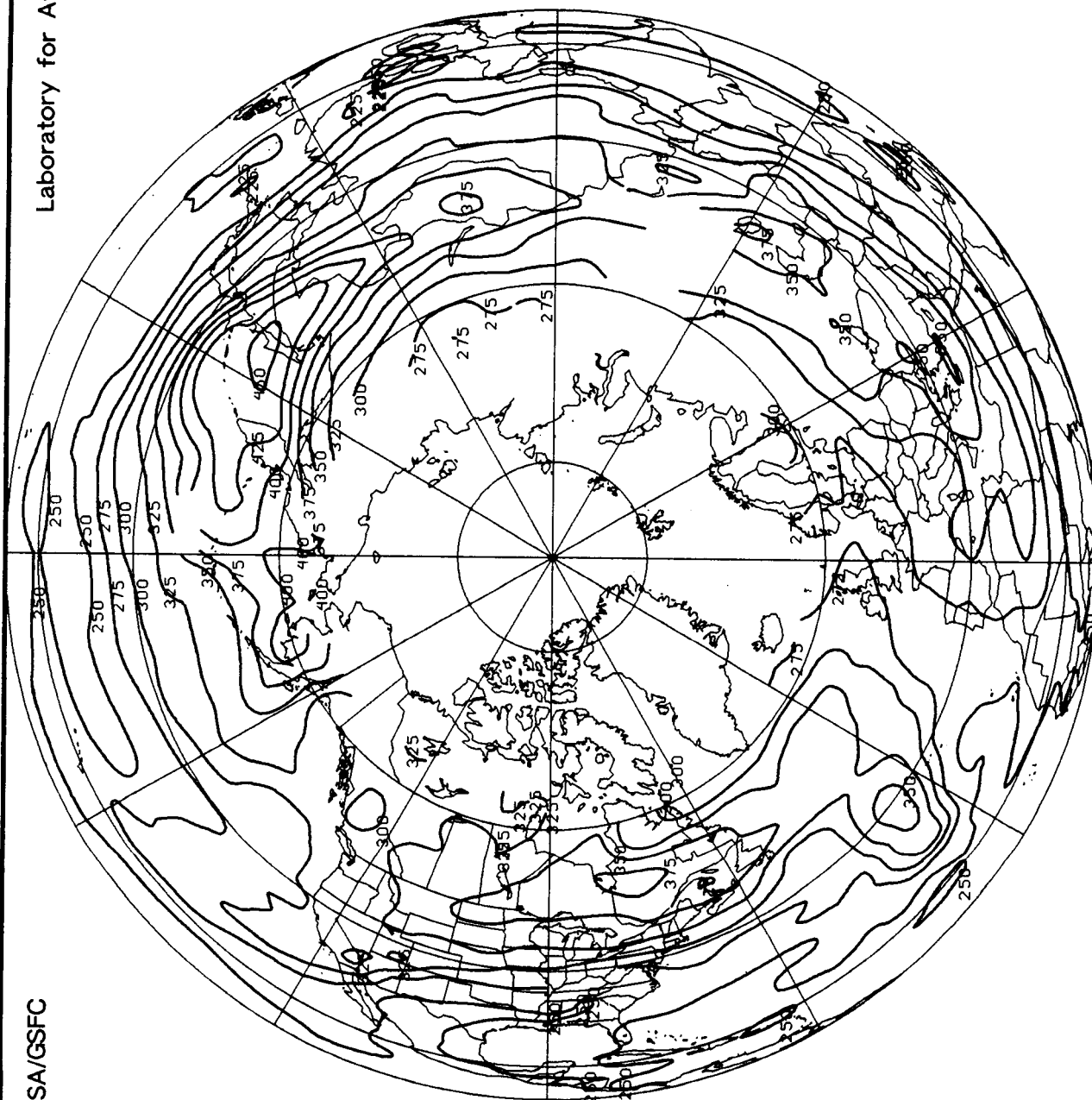


December 28, 1988

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

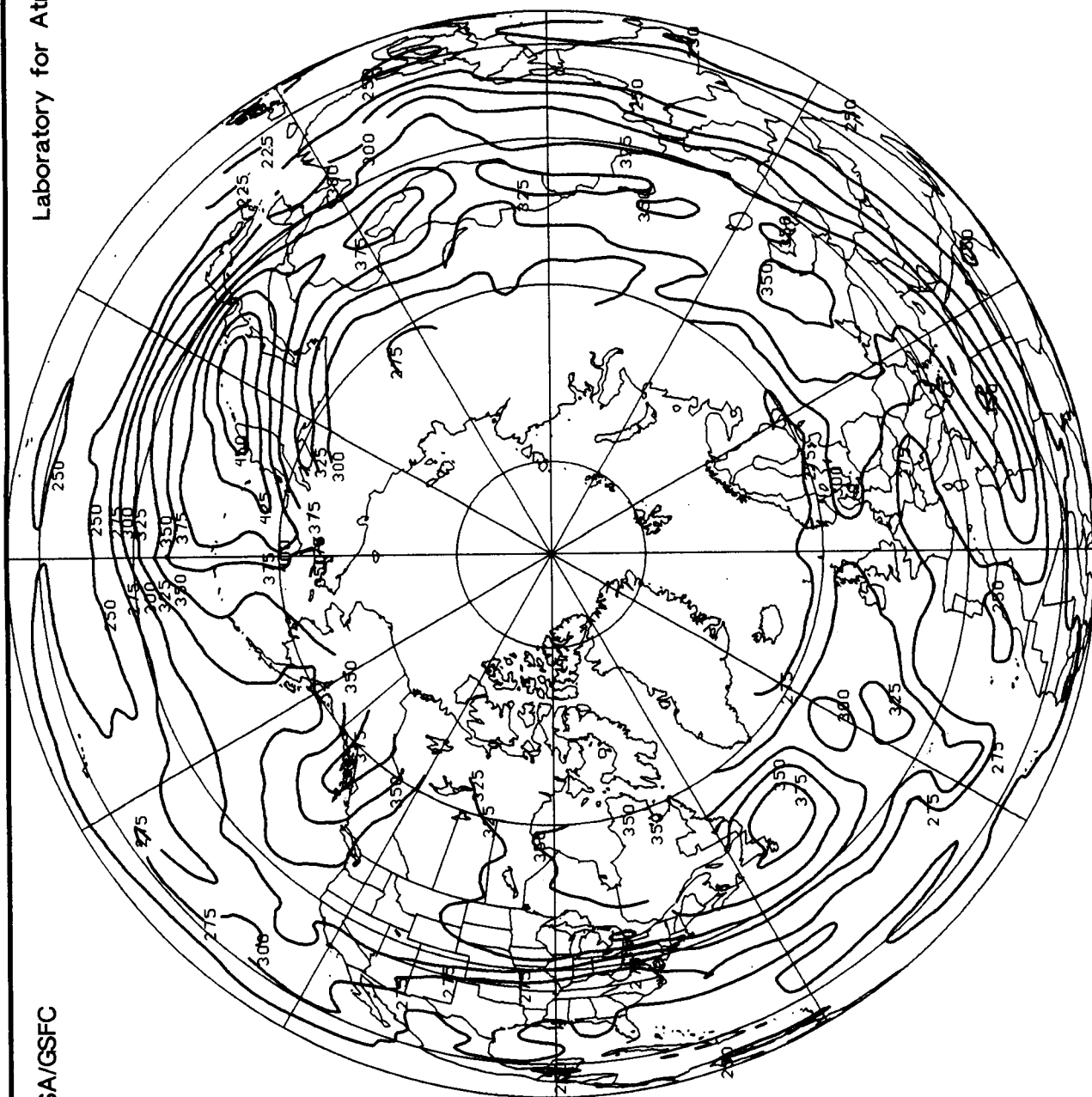


December 29, 1988

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

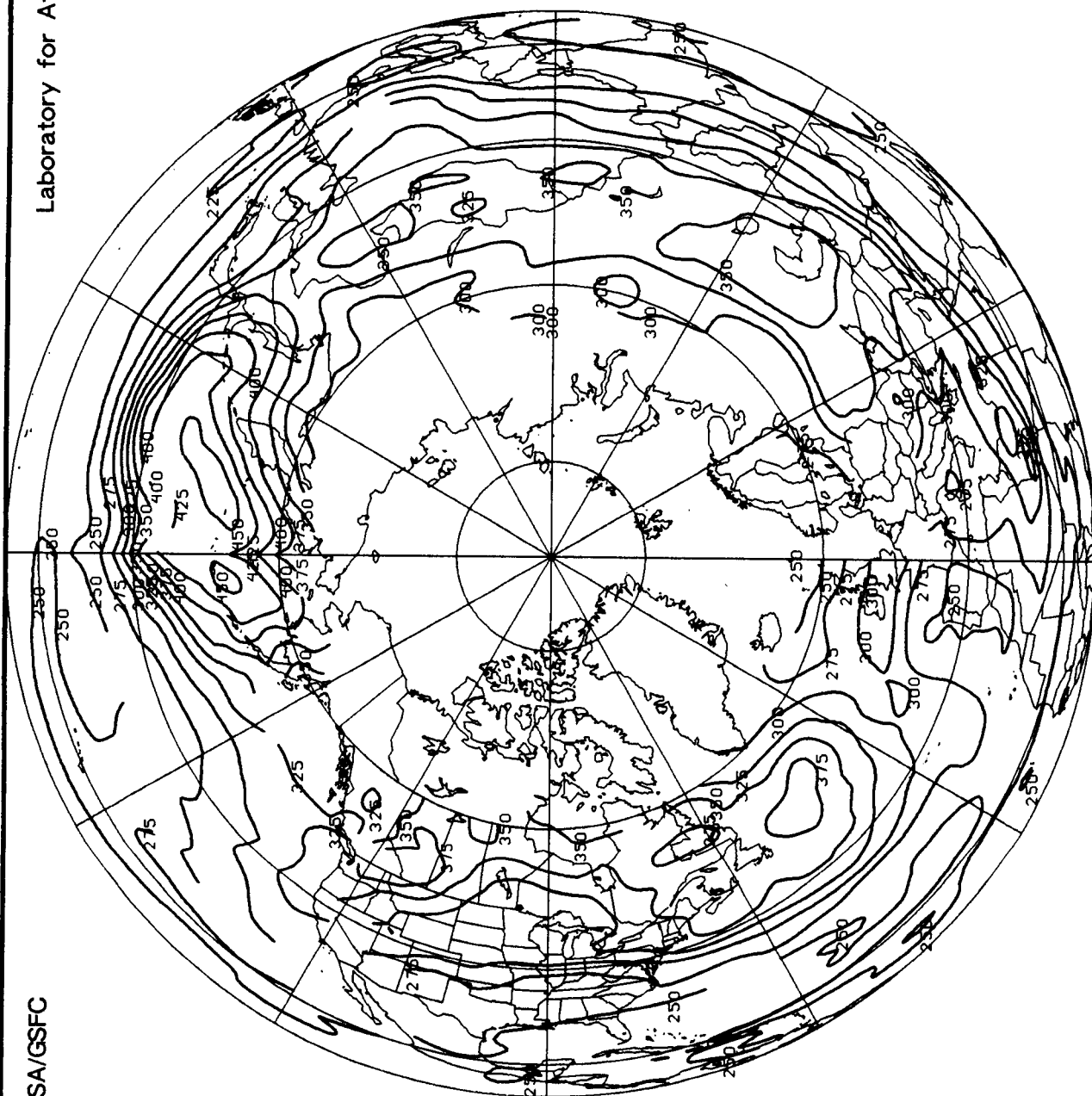


Gridded TOMS Ozone (Dobson Units)

December 30, 1988

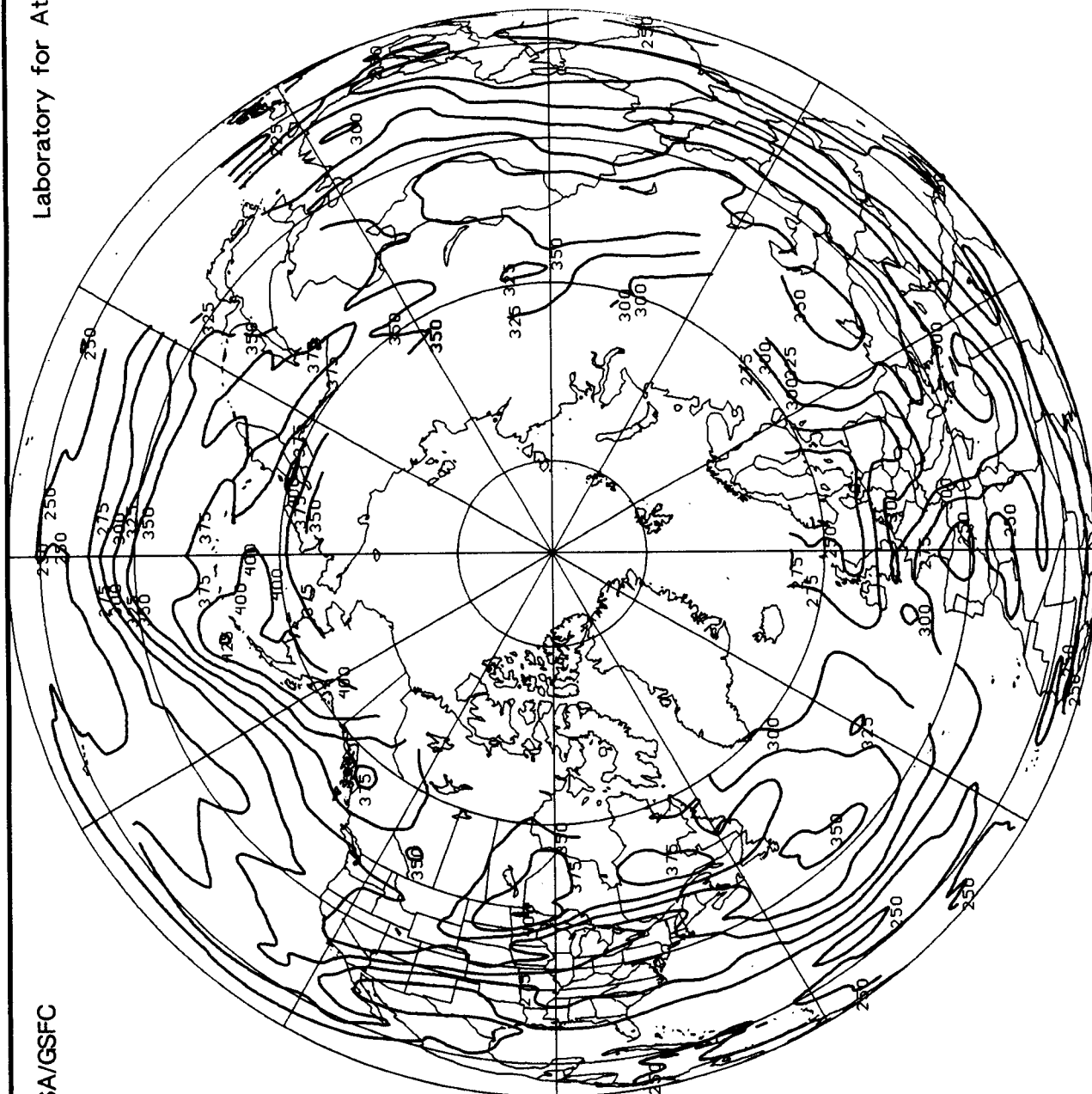
NASA/GSFC

Laboratory for Atmospheres



December 31, 1988

Gridded TOMS Ozone (Dobson Units)

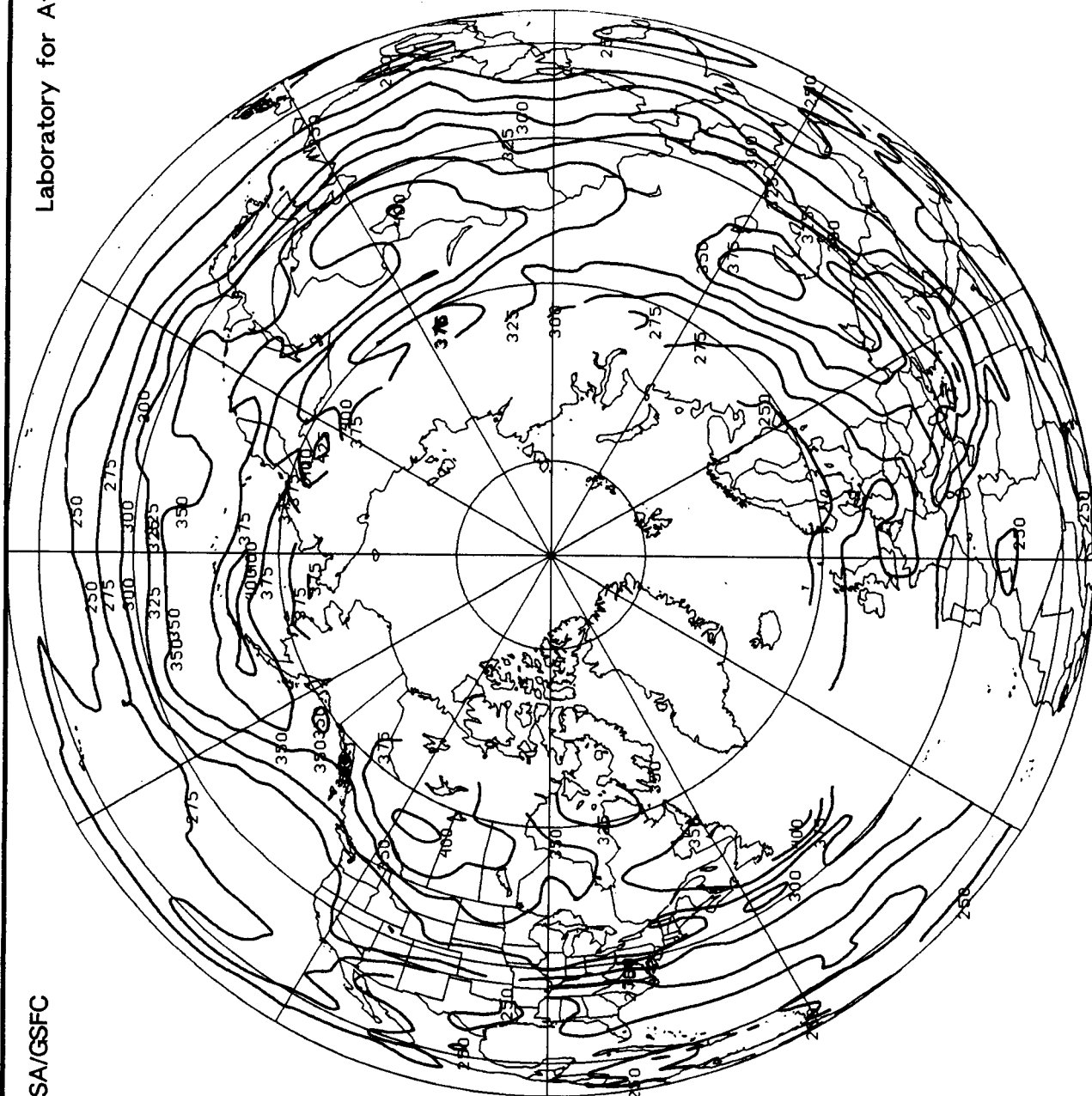


January 1, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

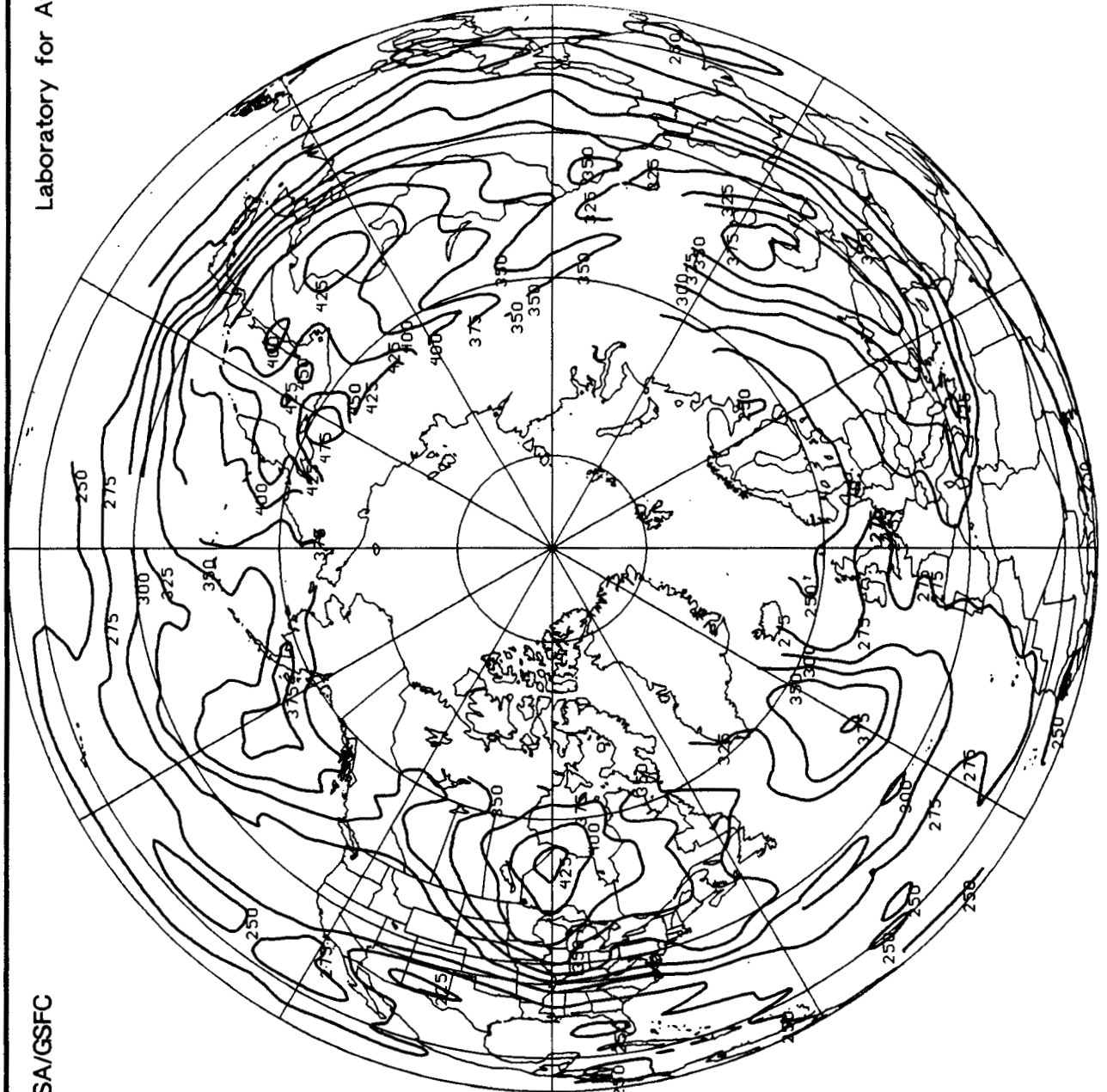


January 2, 1989

Gridded TOMS Ozone (Dobson Units)

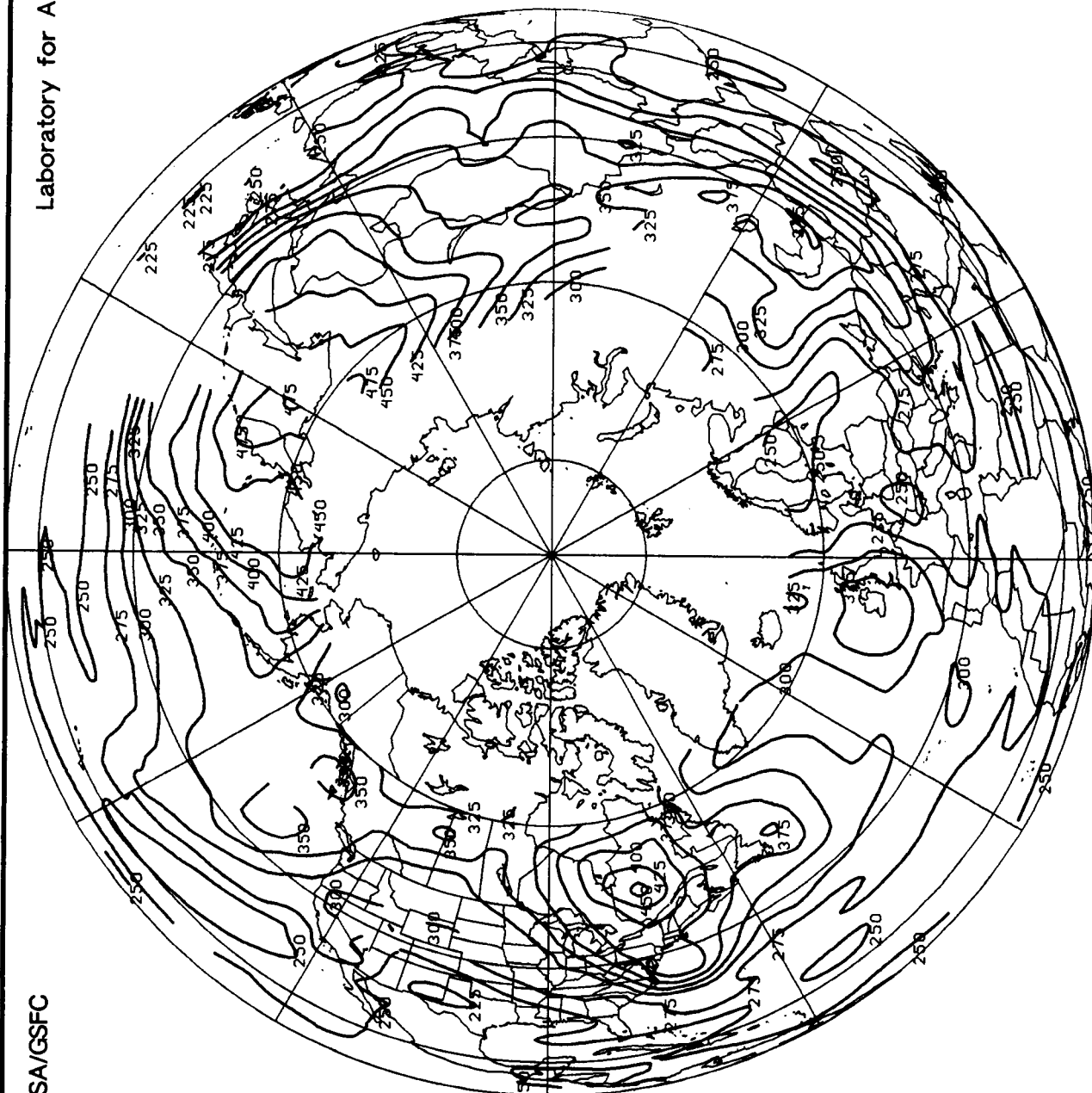
NASA/GSFC

Laboratory for Atmospheres



January 3, 1989

Gridded TOMS Ozone (Dobson Units)

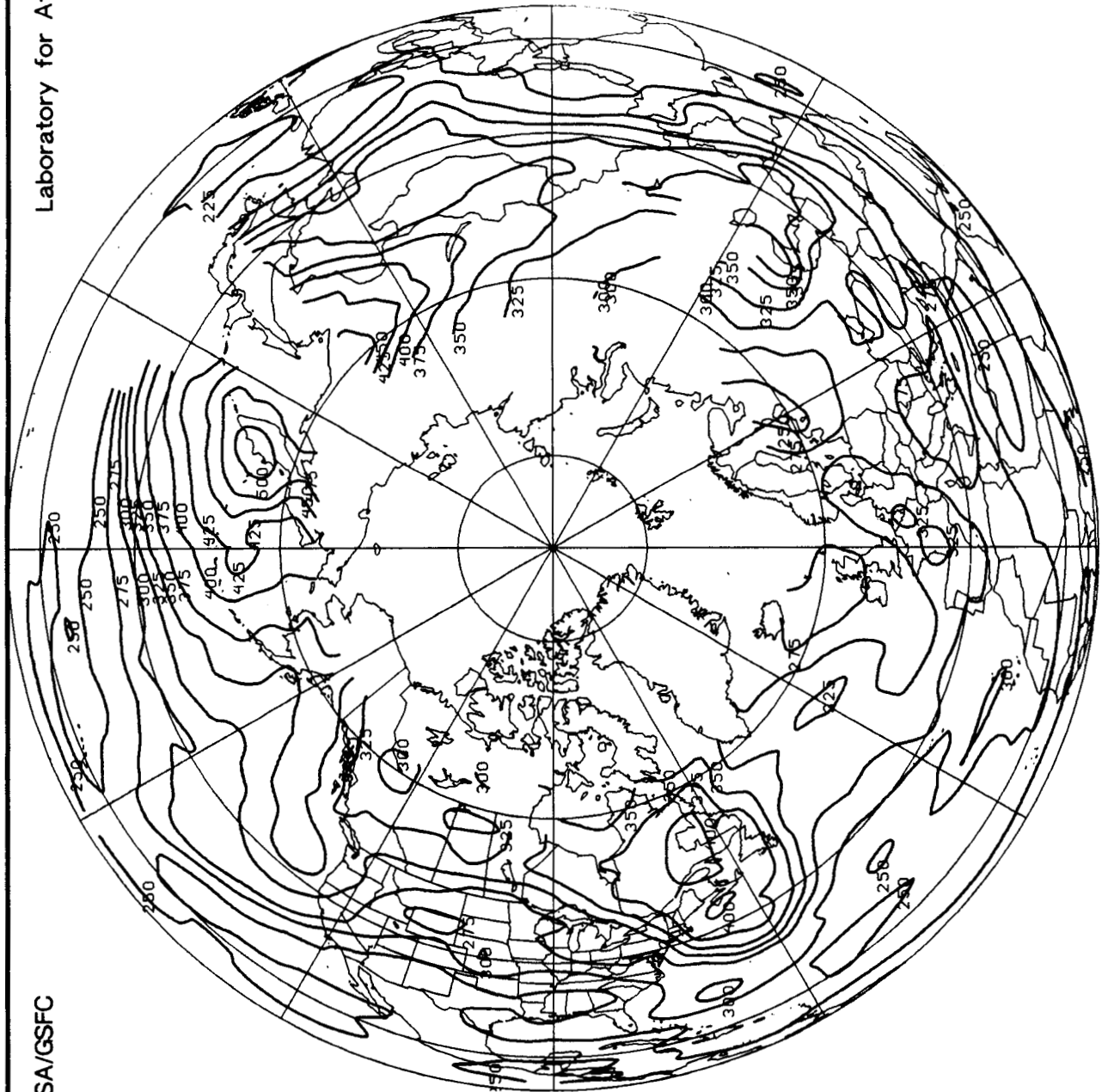


January 4, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

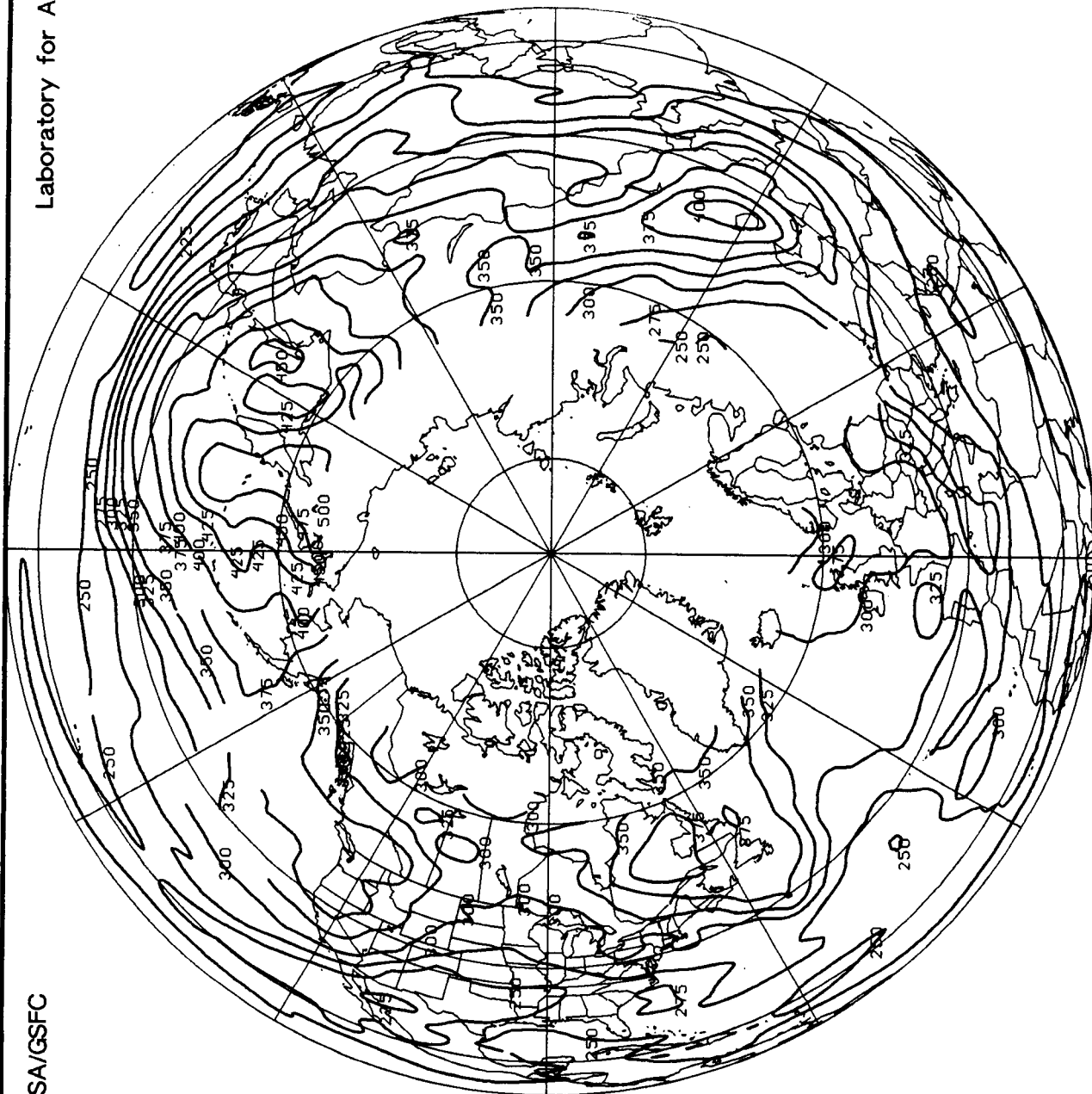


January 5, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

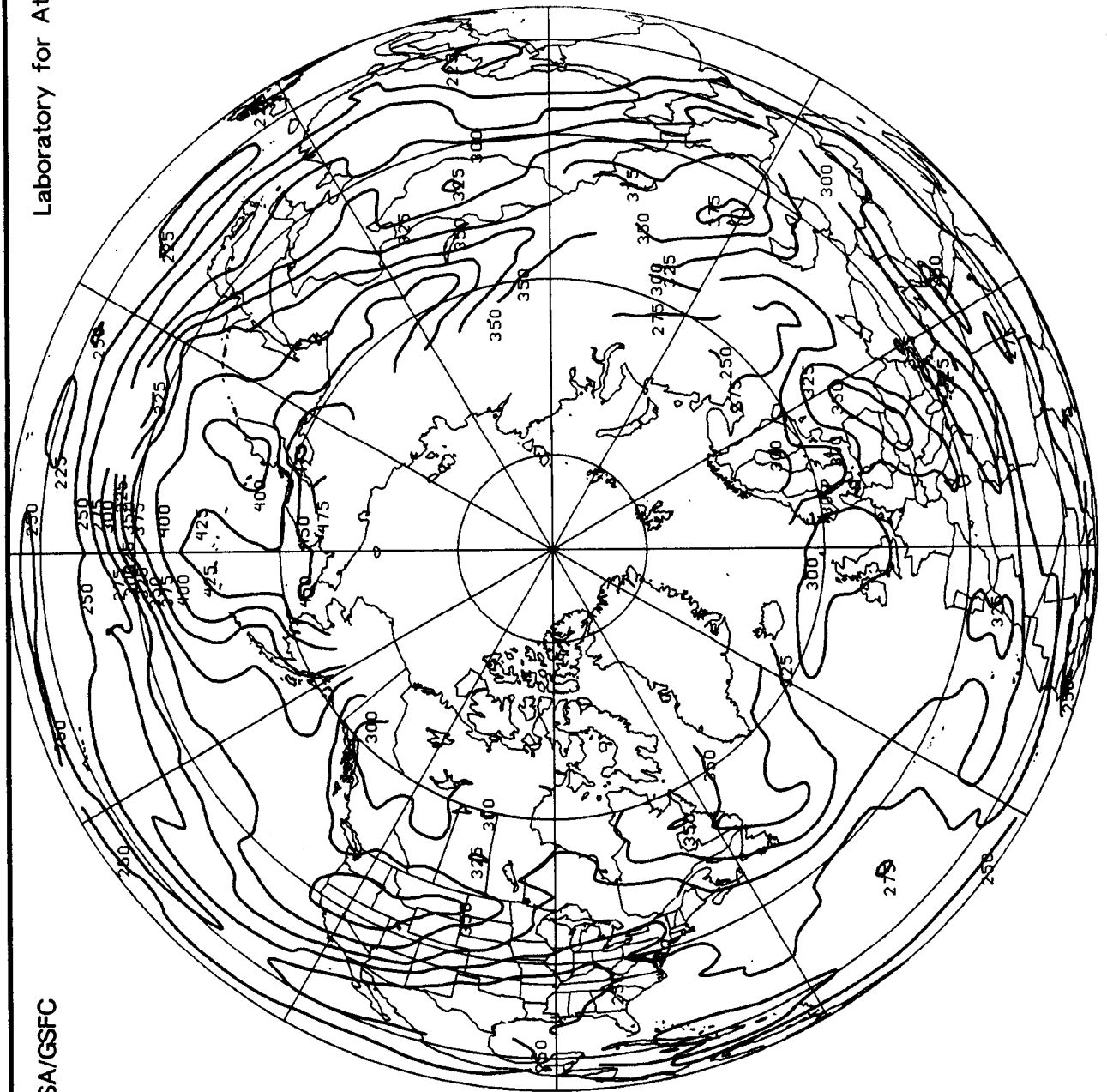


January 6, 1989

Gridded TOMS Ozone (Dobson Units)

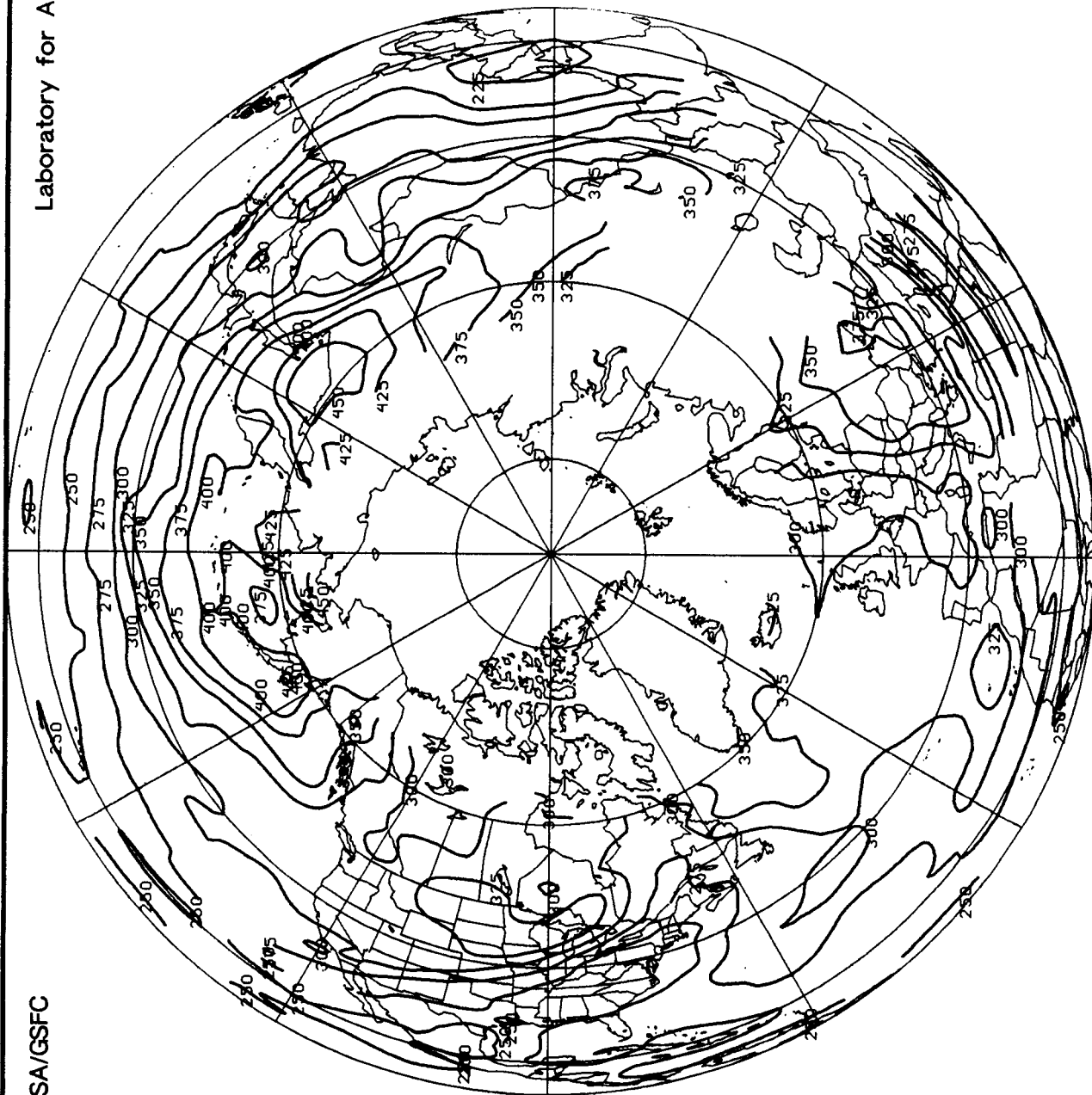
NASA/GSFC

Laboratory for Atmospheres



January 7, 1989

Gridded TOMS Ozone (Dobson Units)

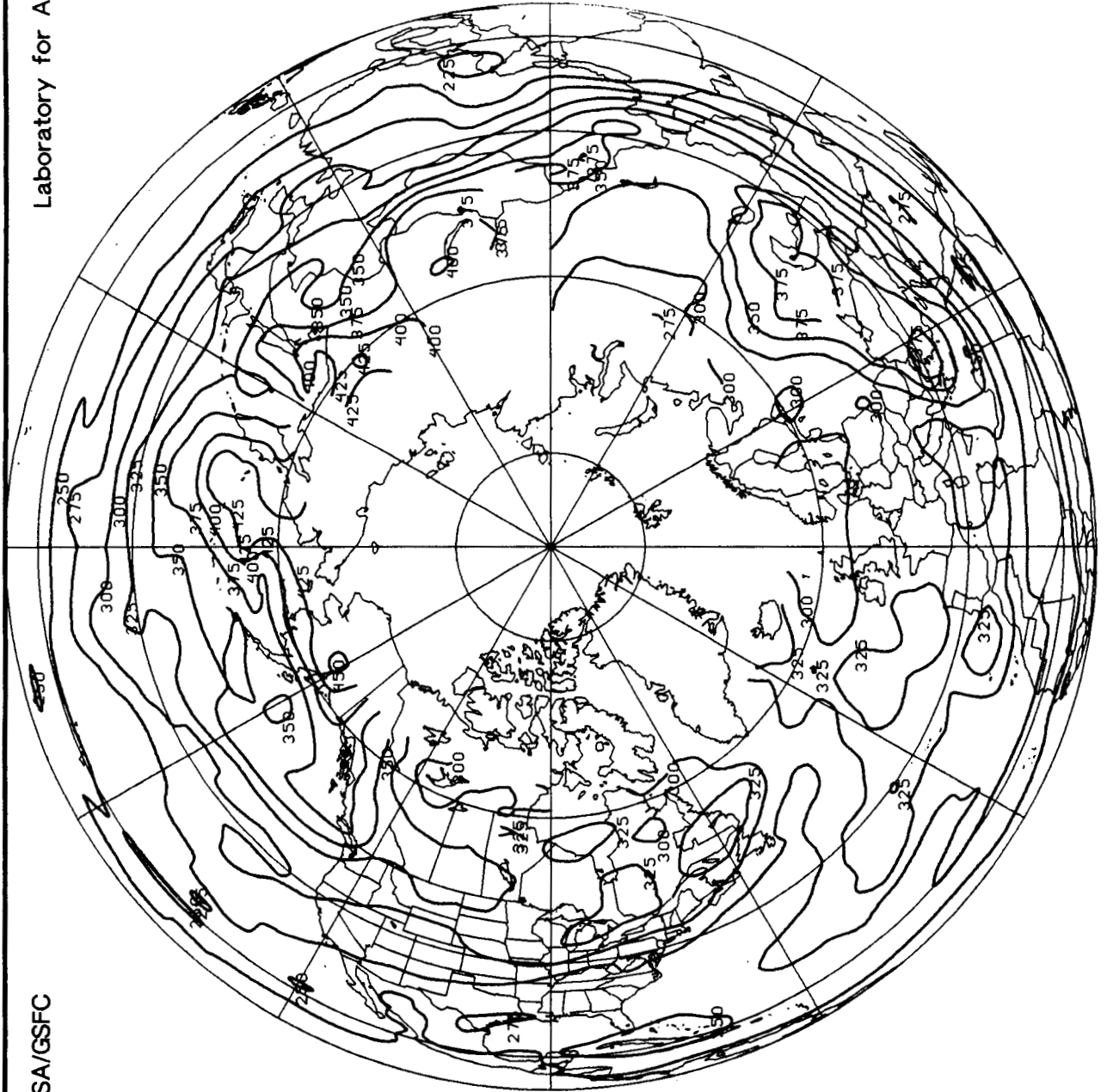


January 8, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

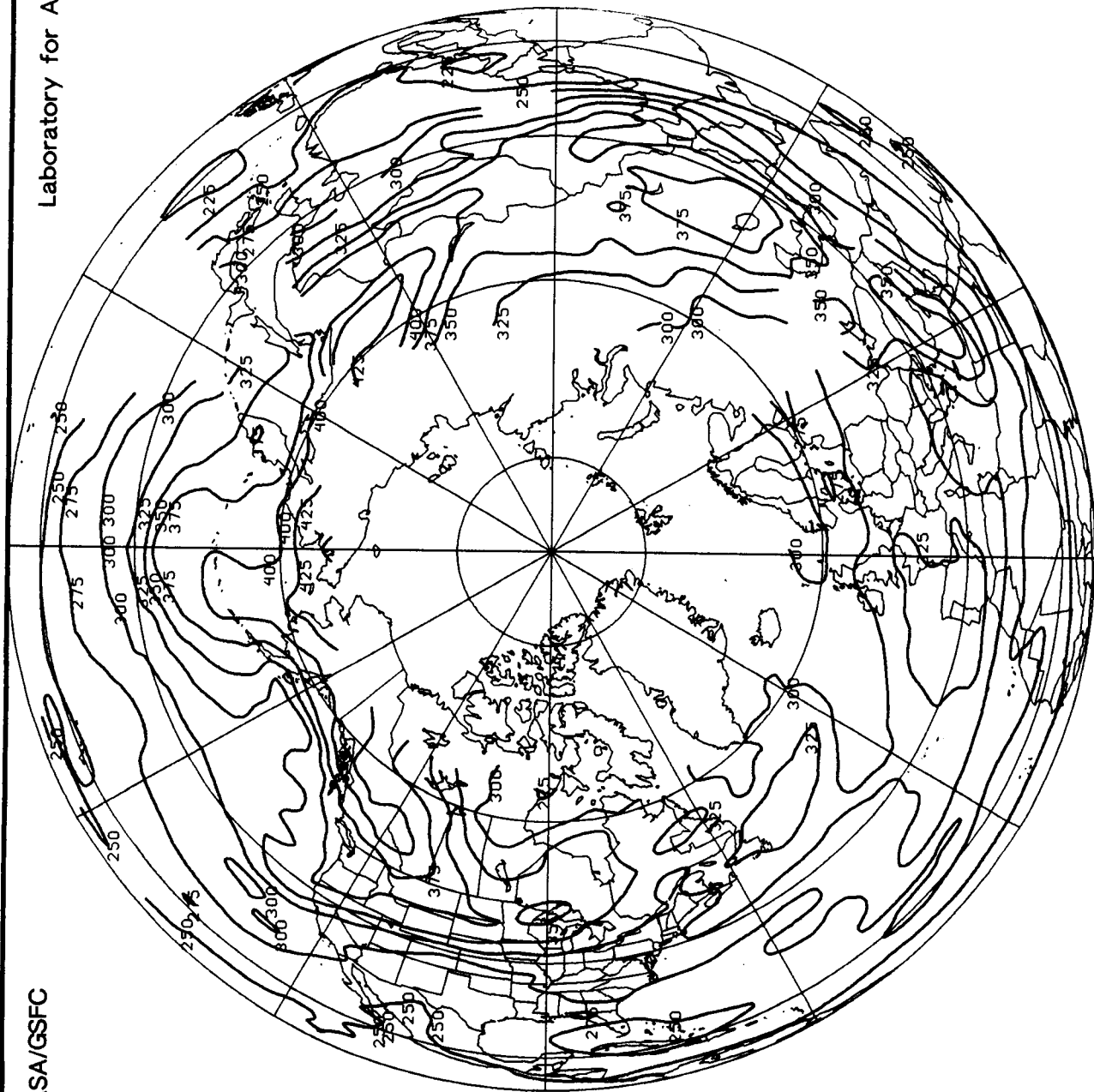


January 9, 1989

Gridded TOMS Ozone (Dobson Units)

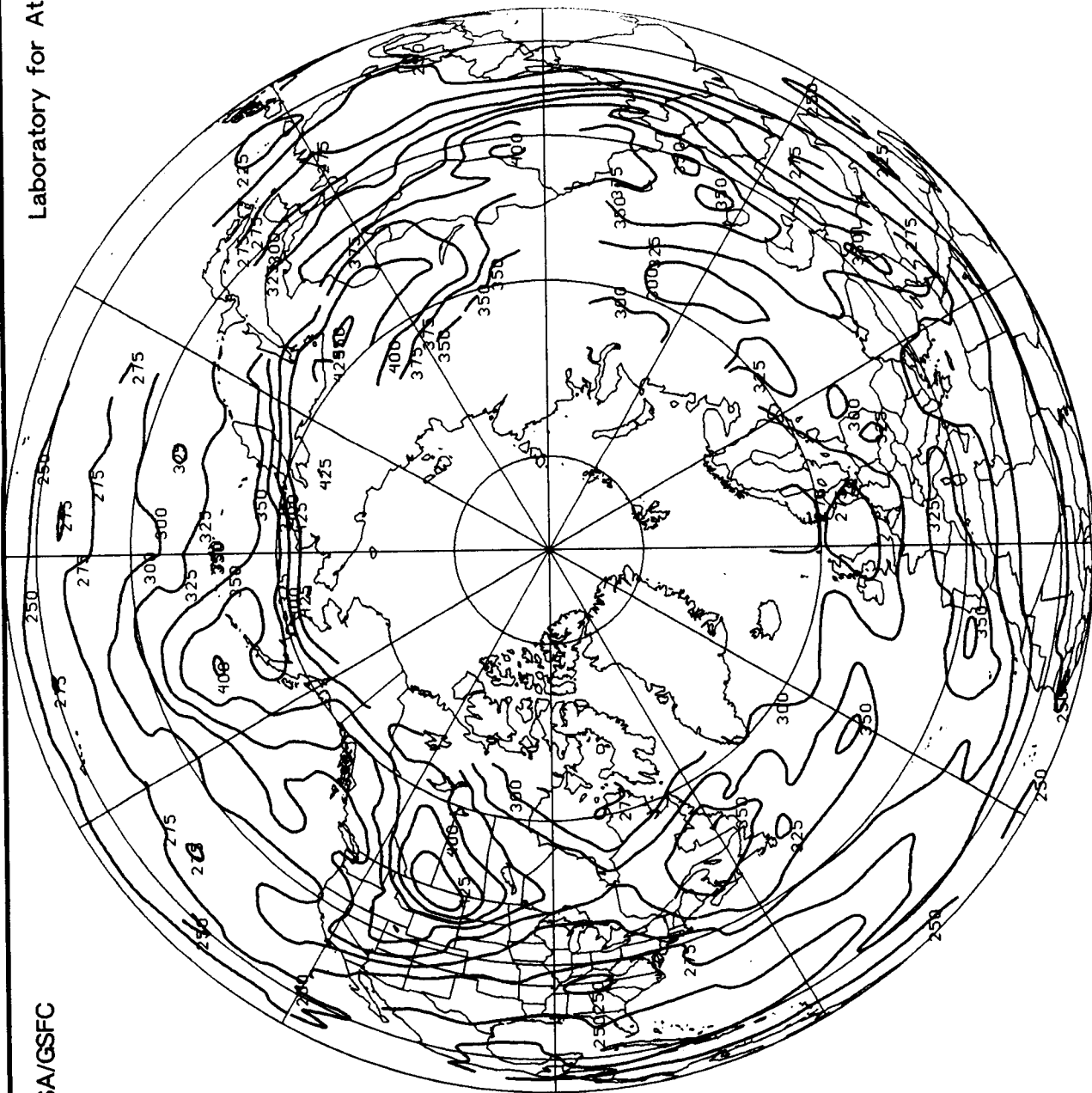
NASA/GSFC

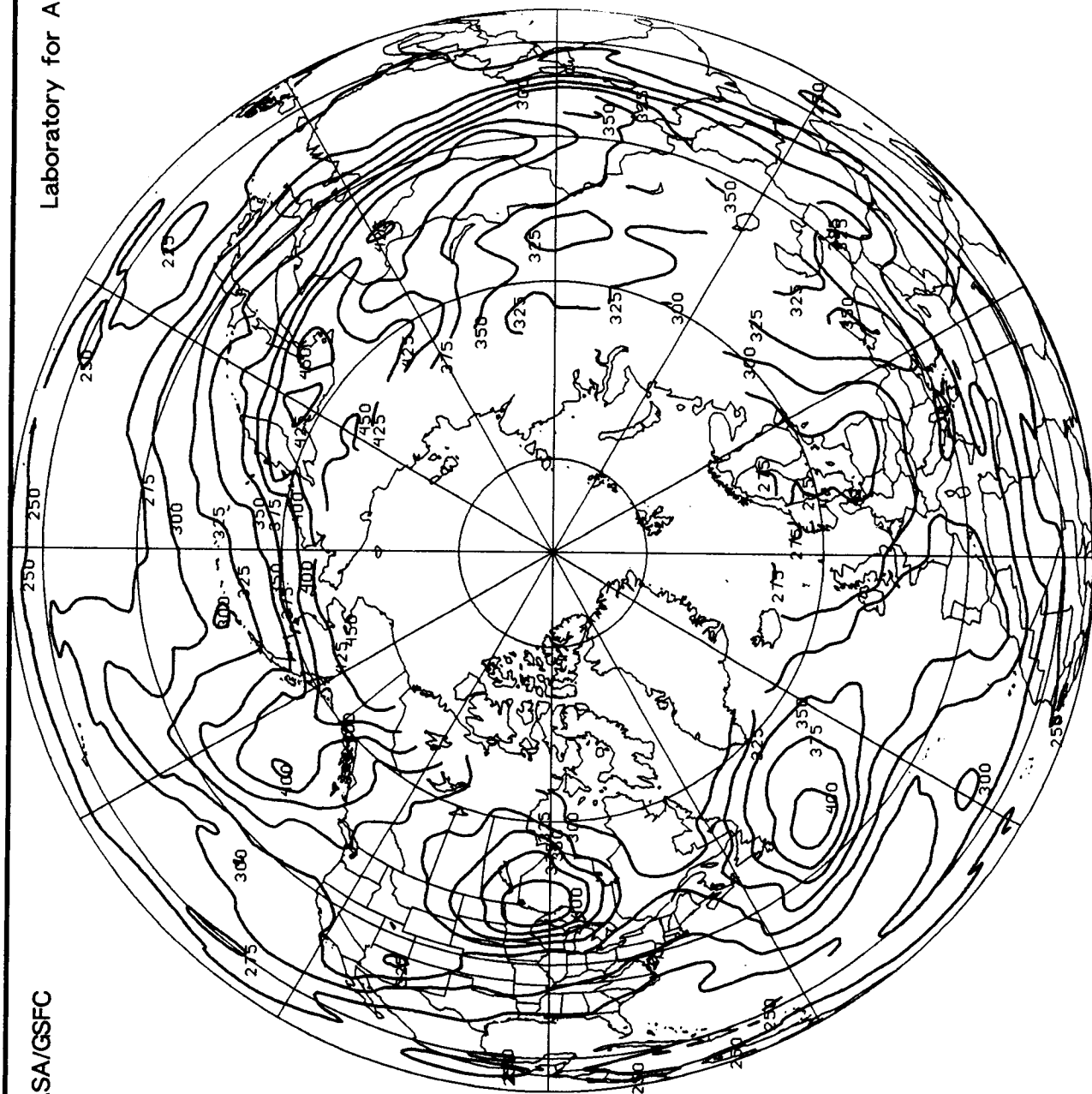
Laboratory for Atmospheres



January 10, 1989

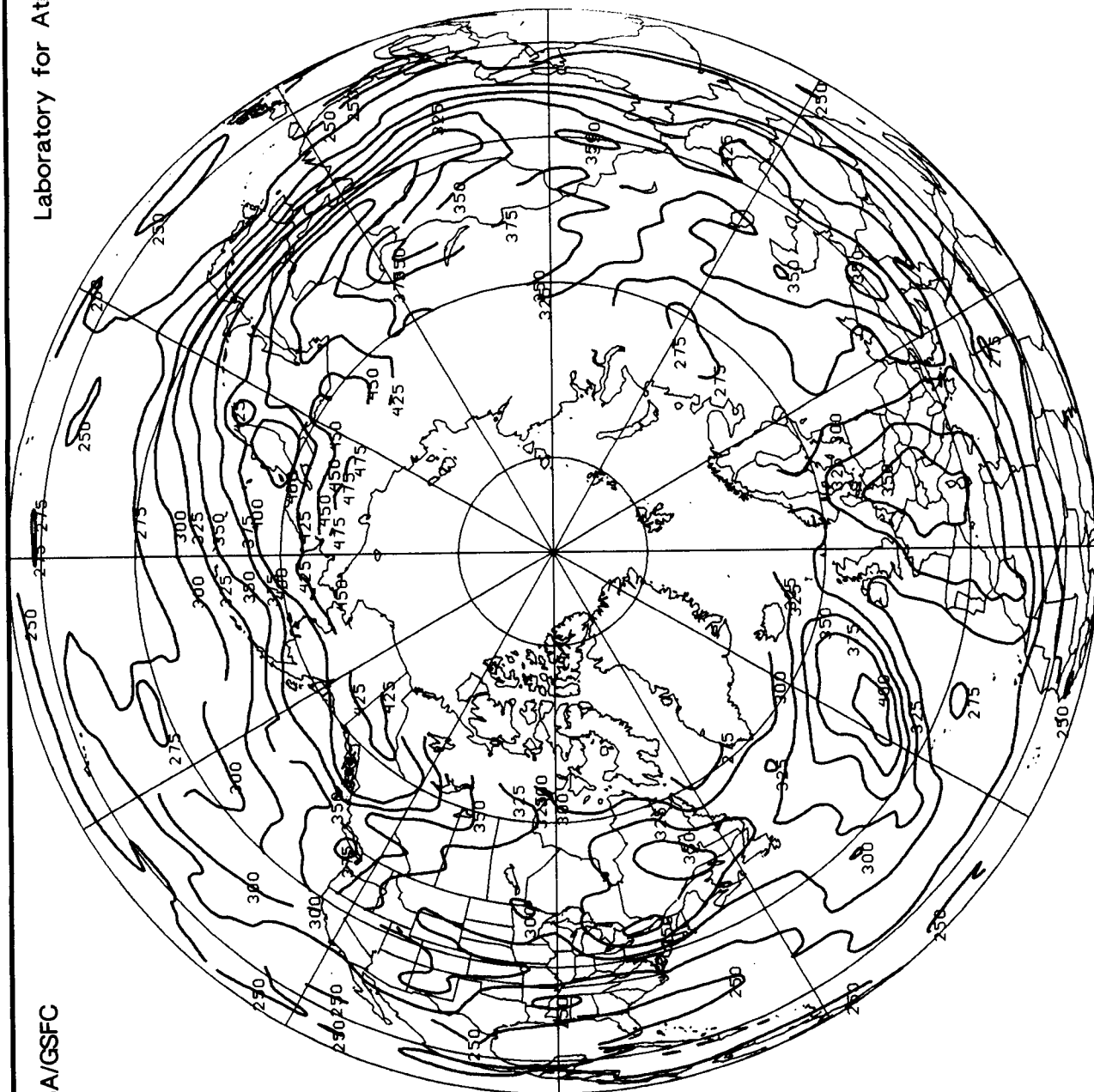
Gridded TOMS Ozone (Dobson Units)





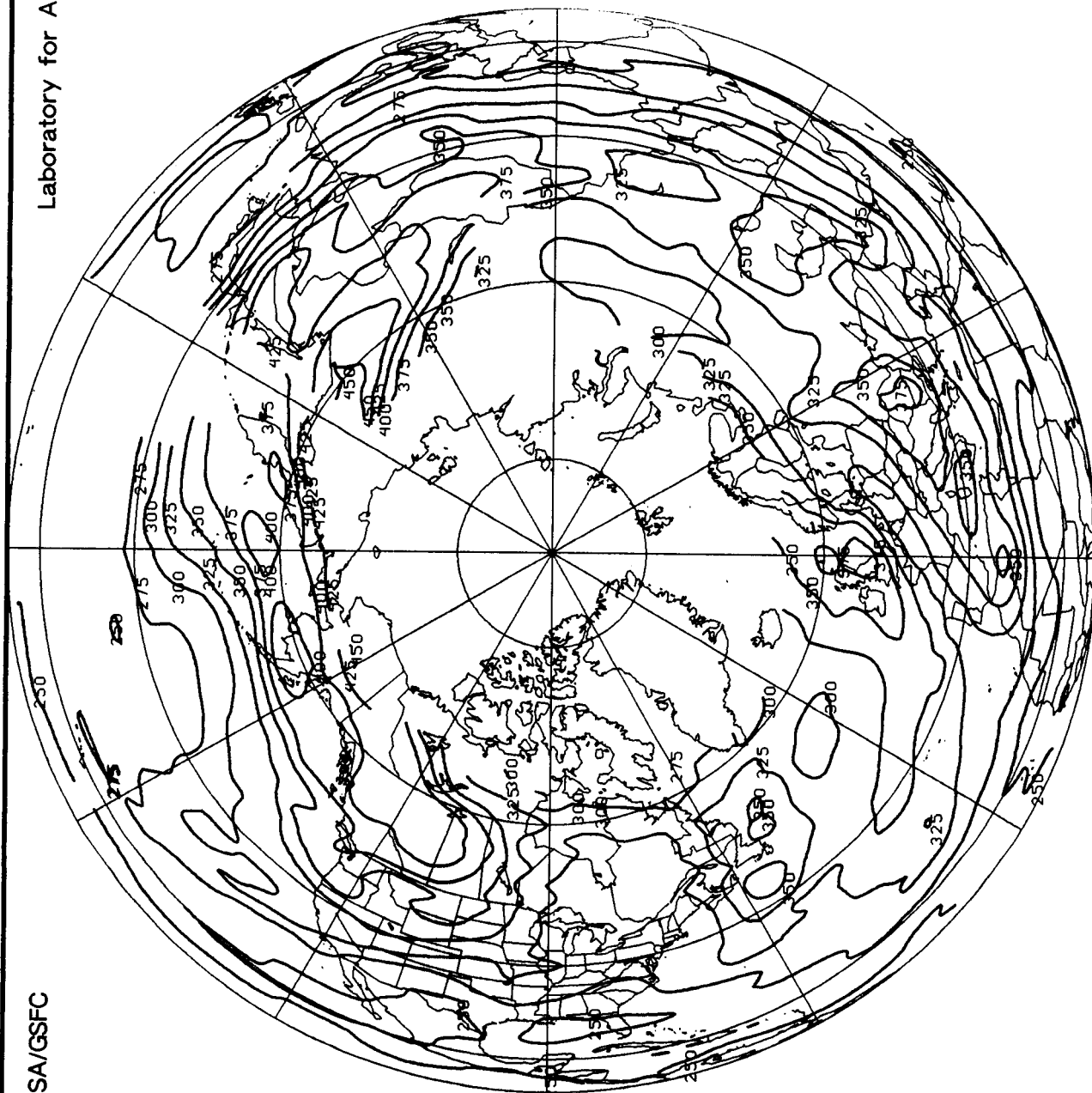
January 12, 1989

Gridded TOMS Ozone (Dobson Units)



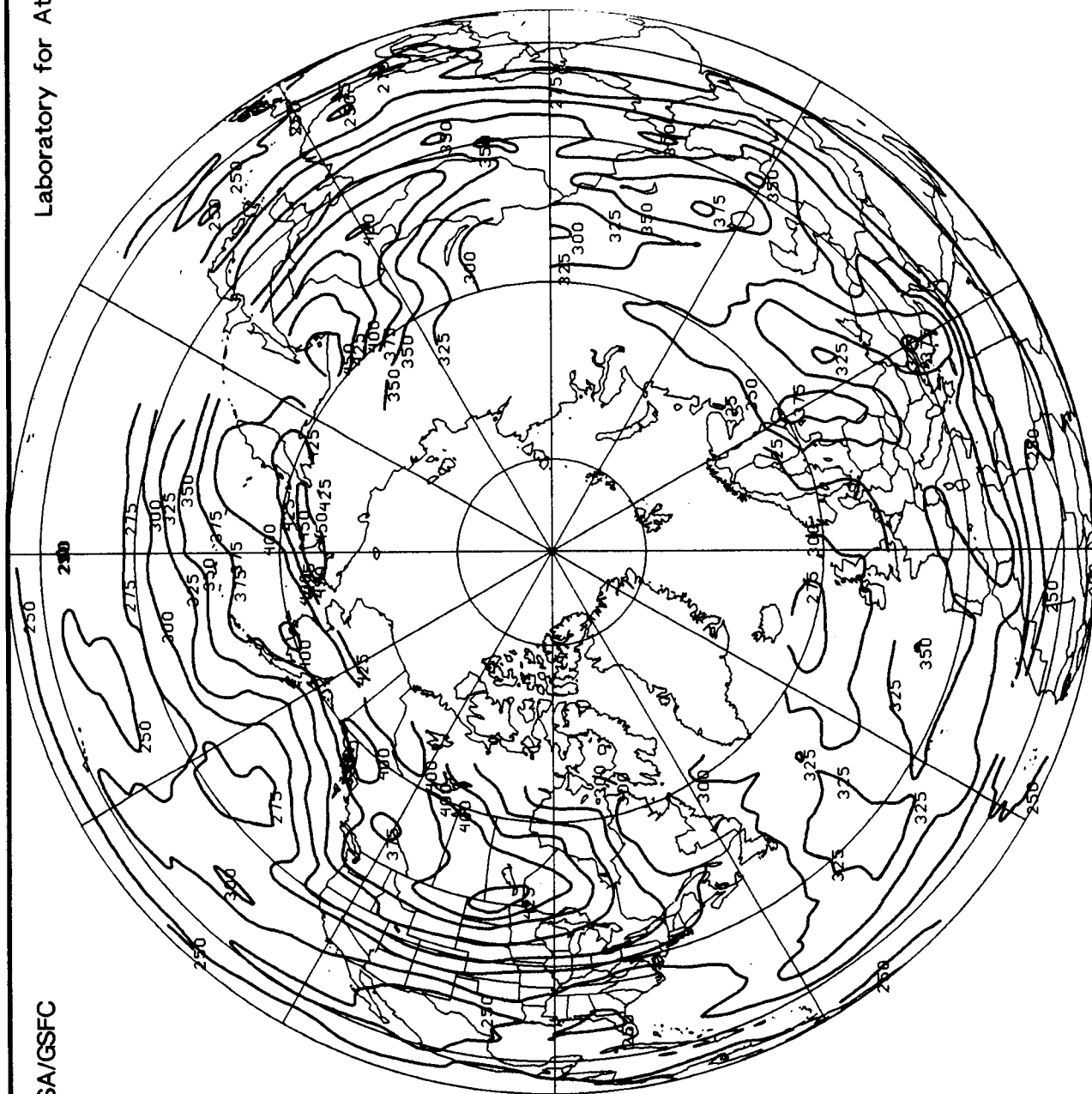
NASA/GSFC

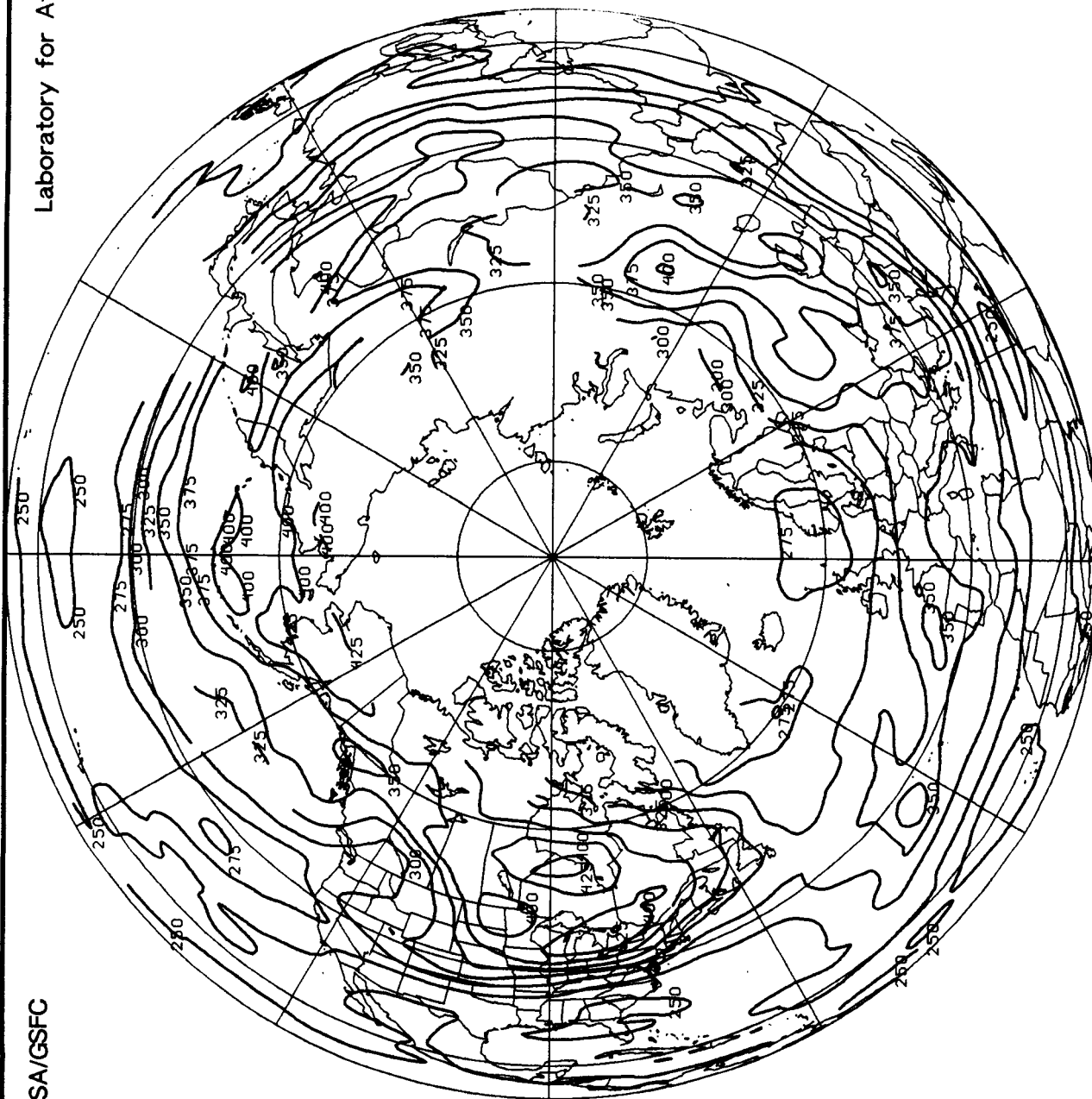
Laboratory for Atmospheres



January 14, 1989

Gridded TOMS Ozone (Dobson Units)



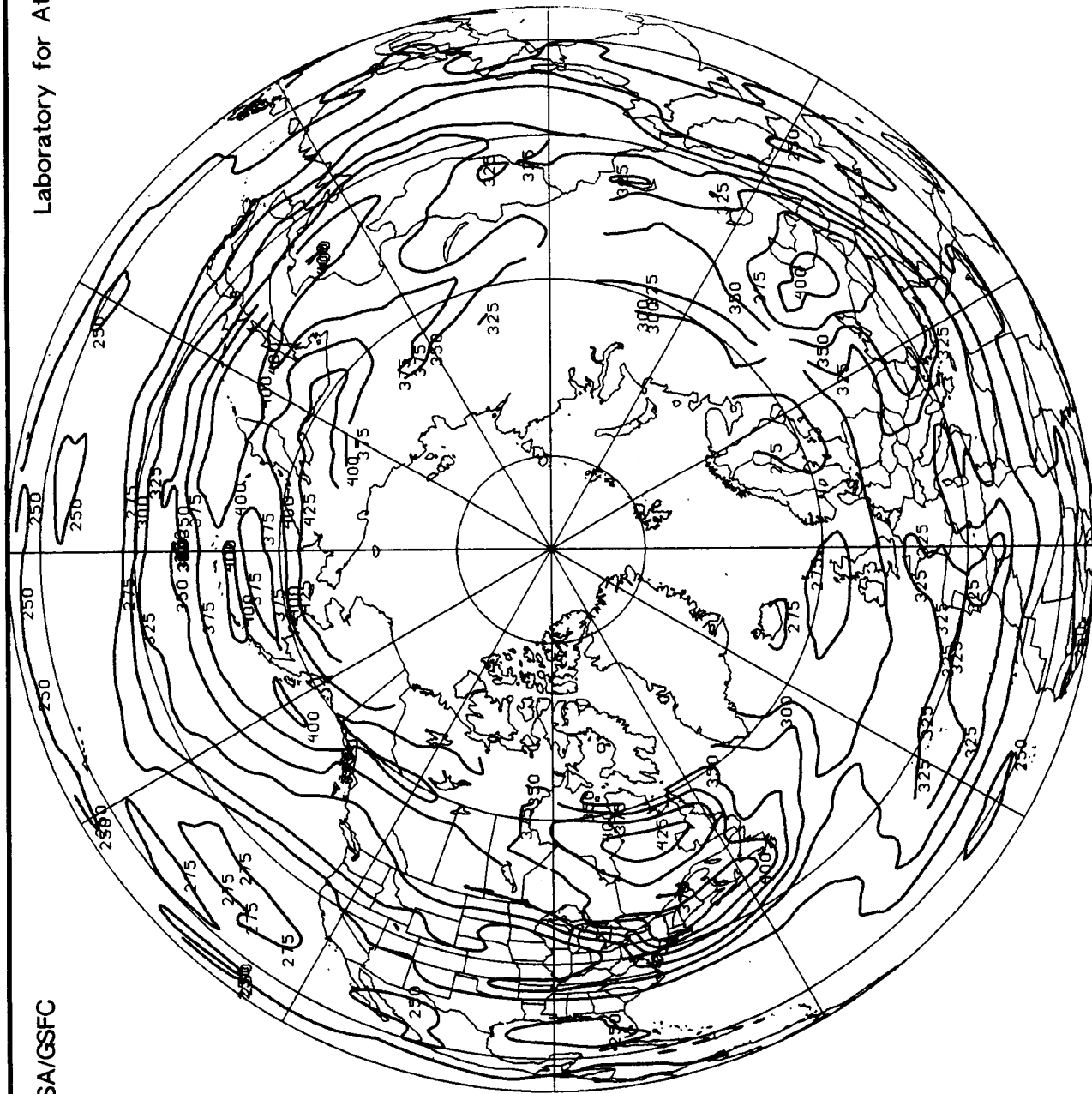


January 16, 1989

Gridded TOMS Ozone (Dobson Units)

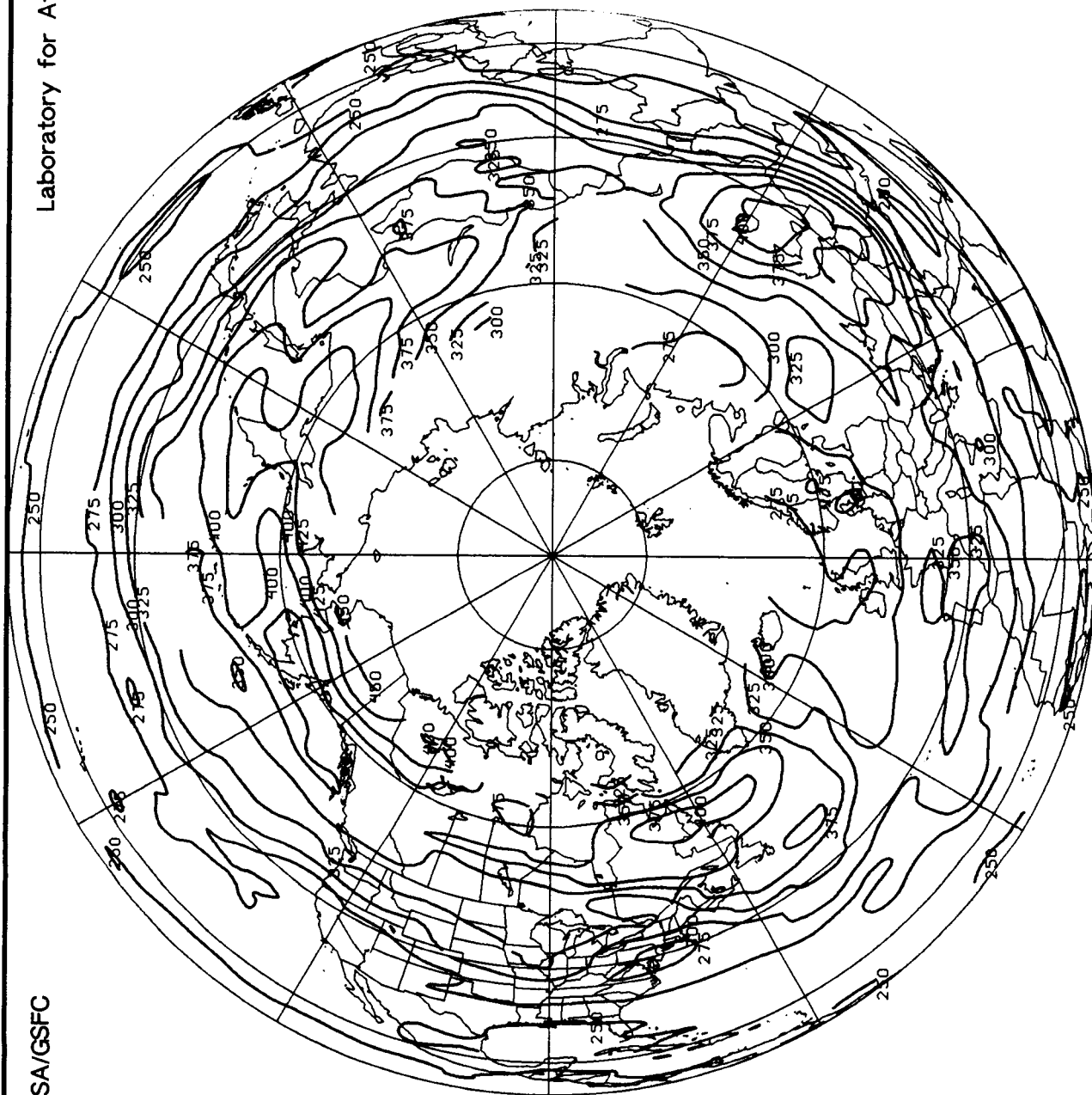
NASA/GSFC

Laboratory for Atmospheres



January 17, 1989

Gridded TOMS Ozone (Dobson Units)

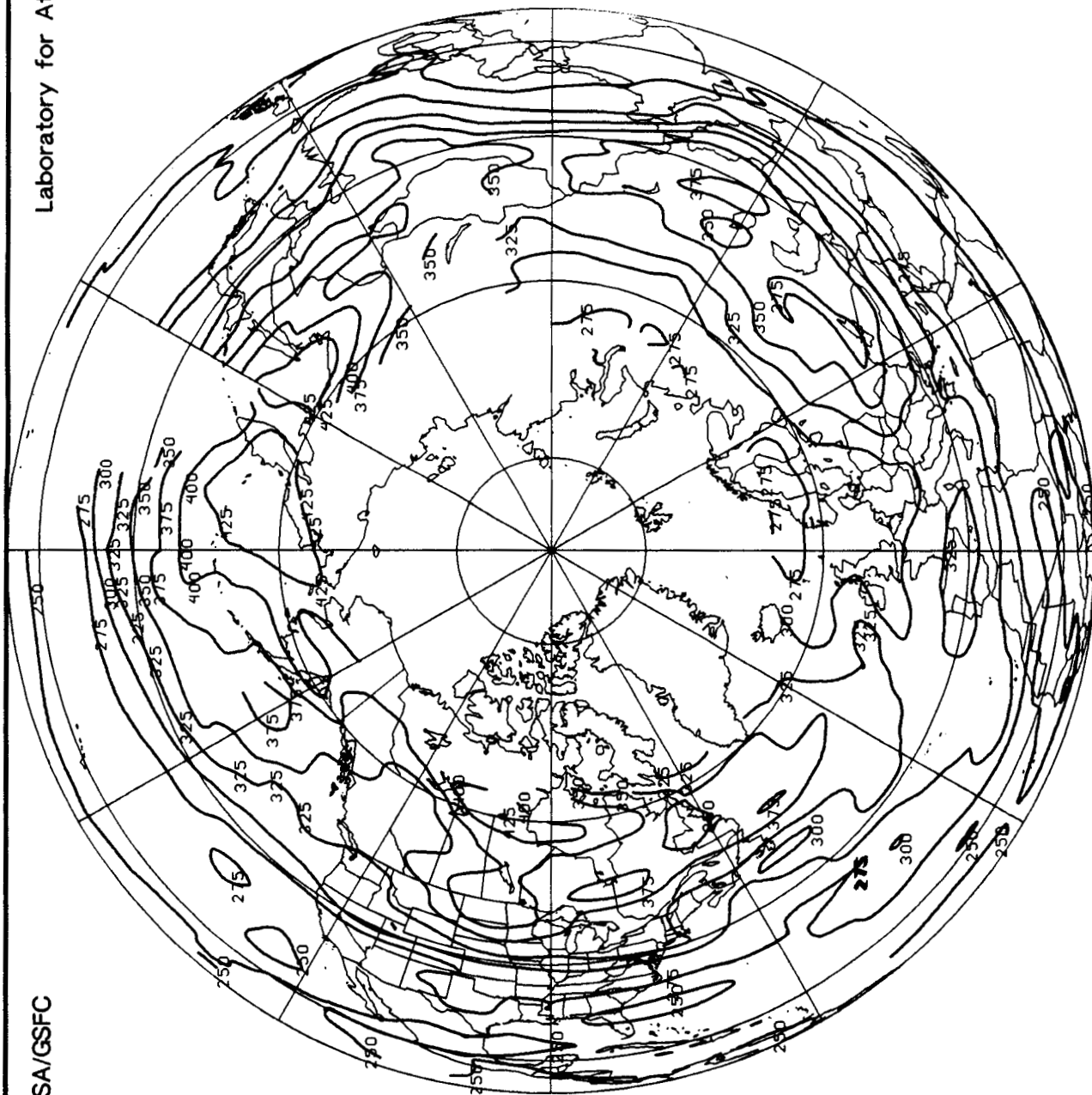


January 18, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

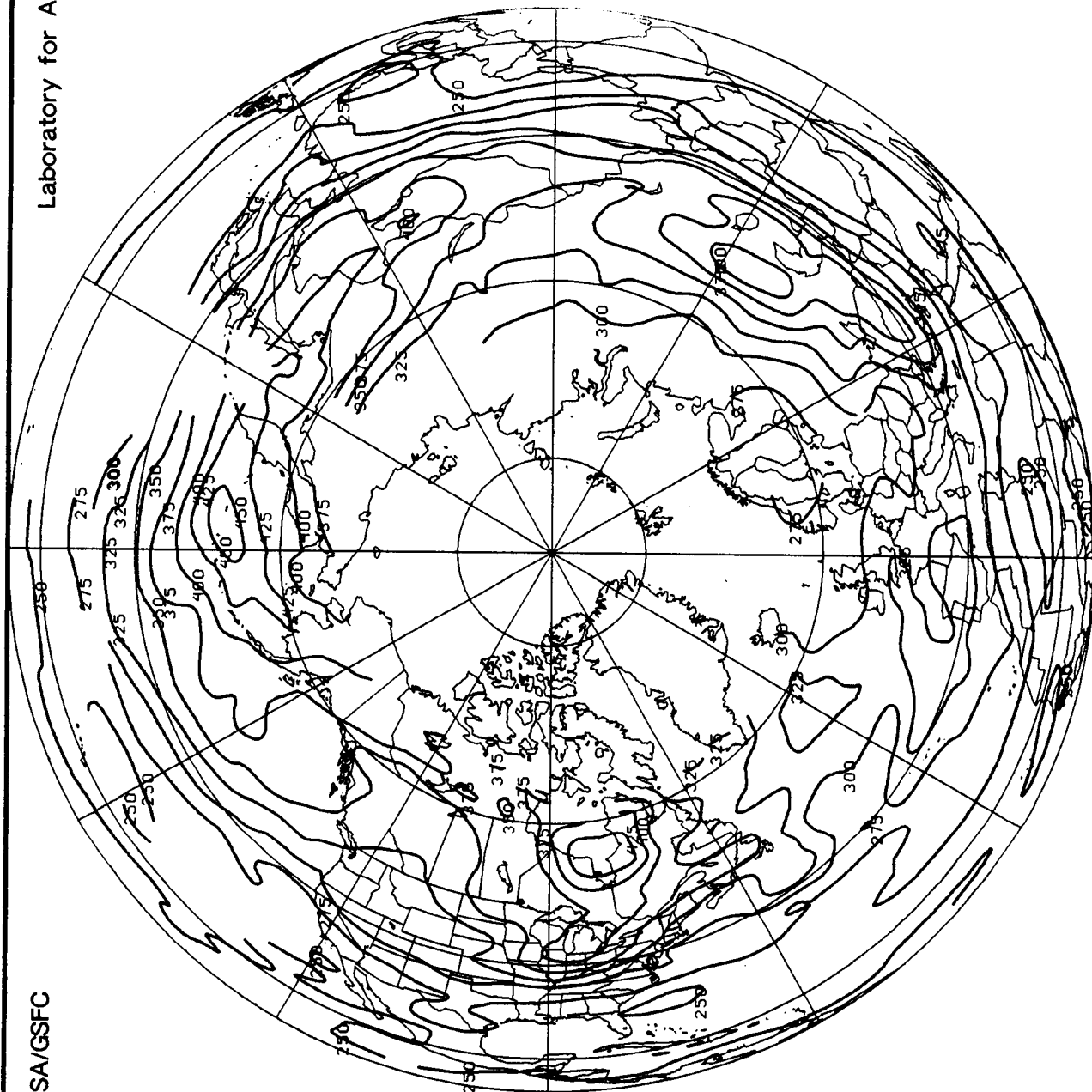


January 19, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

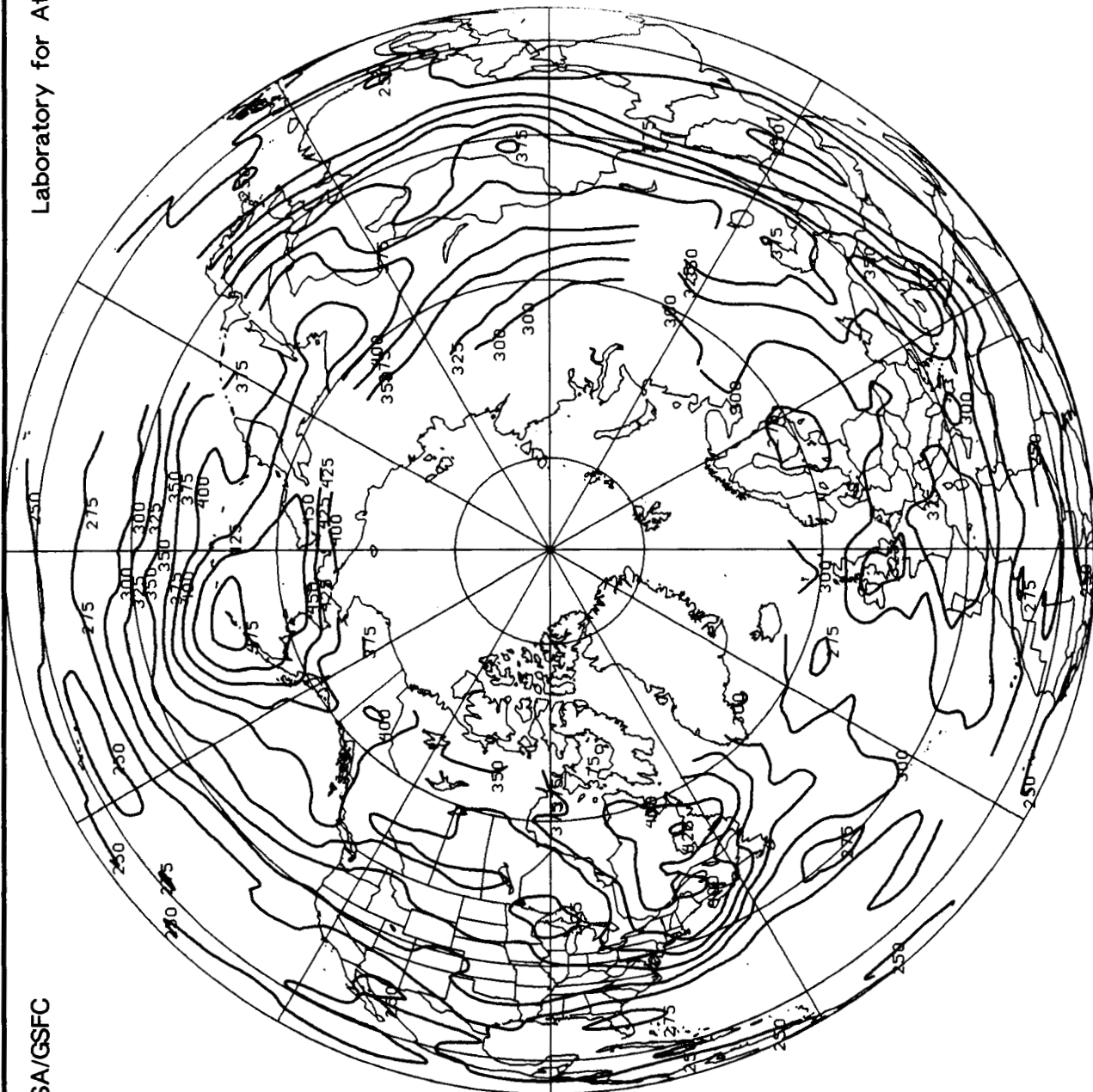


January 20, 1989

Gridded TOMS Ozone (Dobson Units)

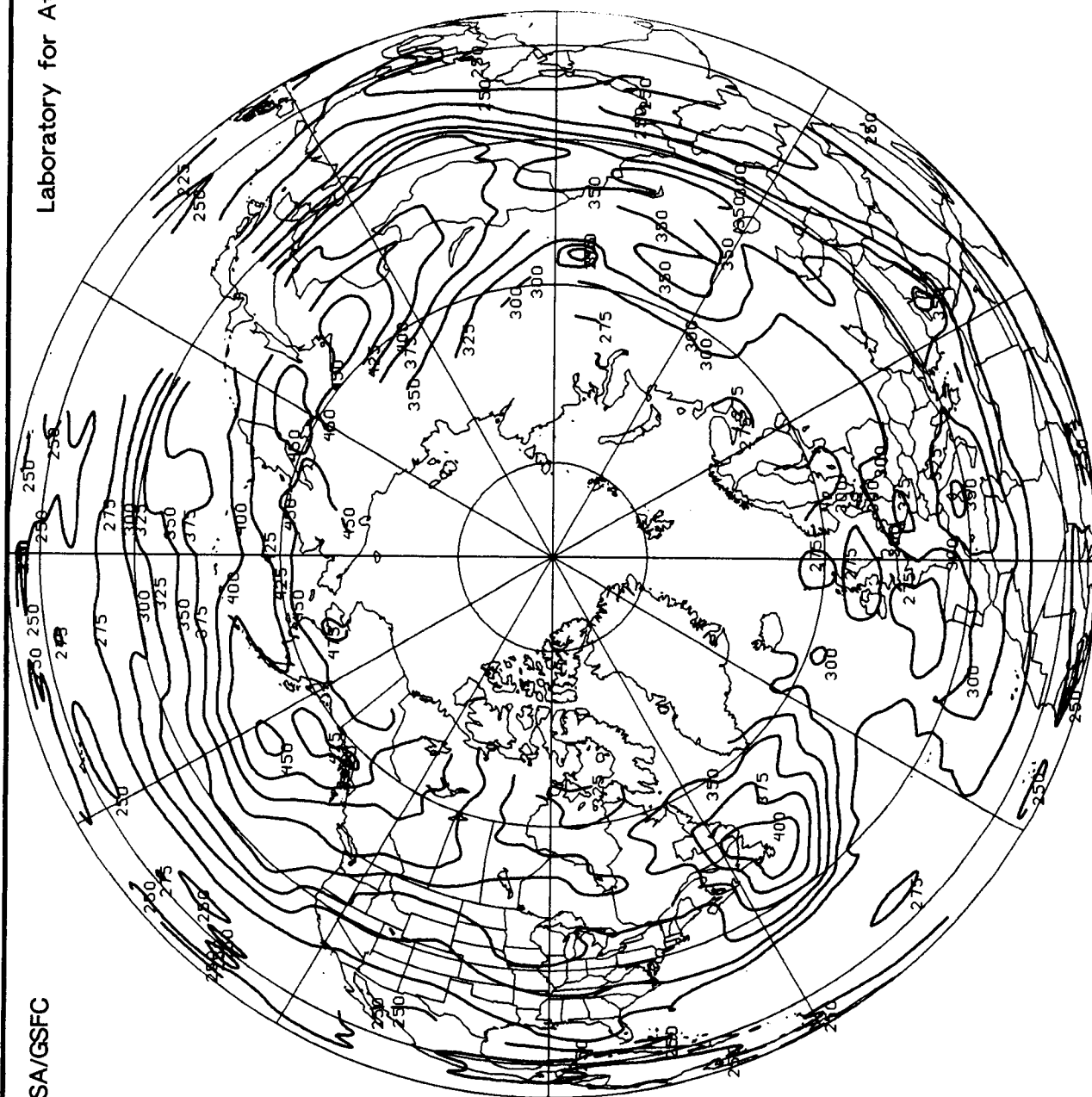
NASA/GSFC

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January 21, 1989

Gridded TOMS Ozone (Dobson Units)

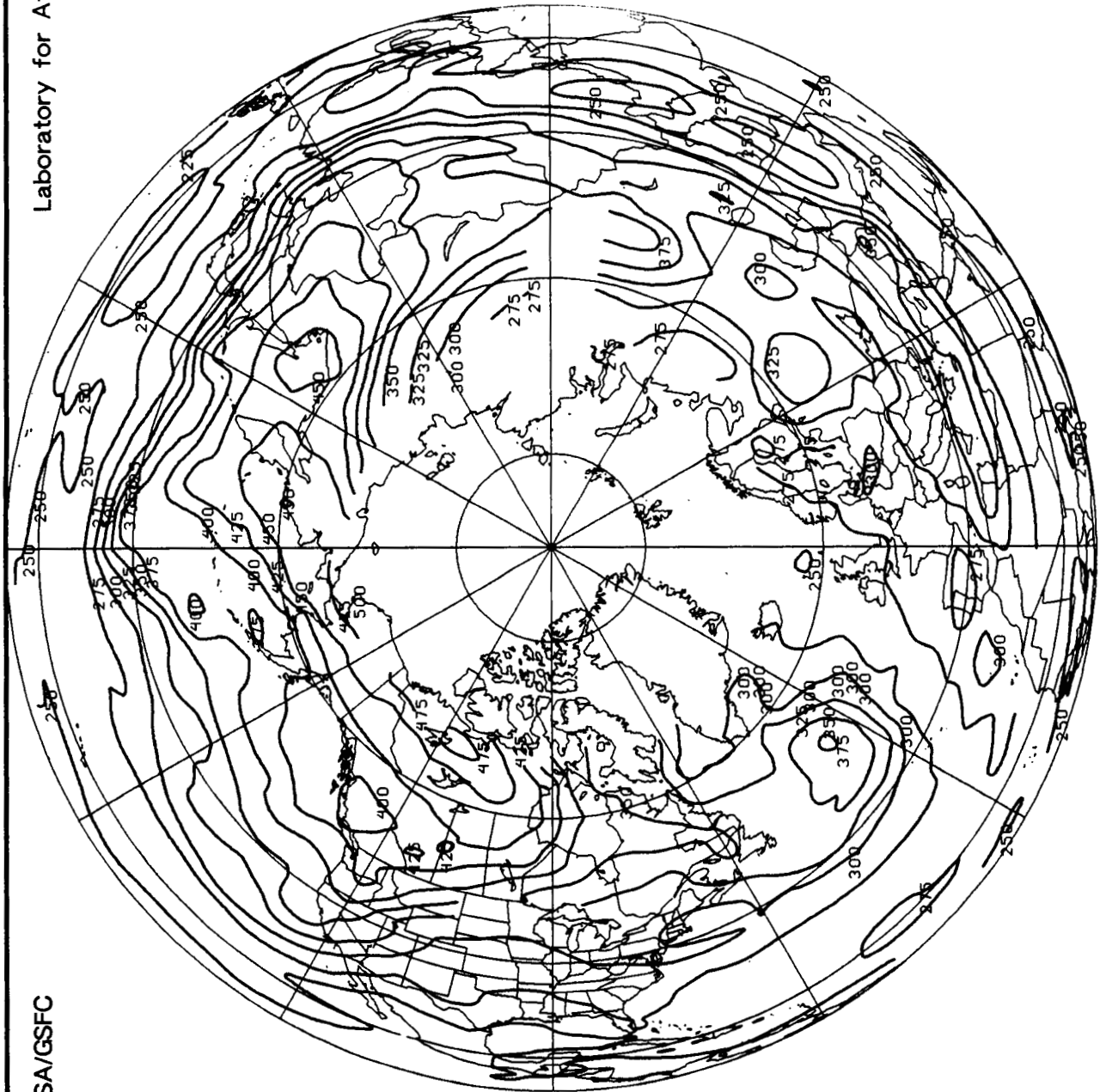


January 22, 1989

Gridded TOMS Ozone (Dobson Units)

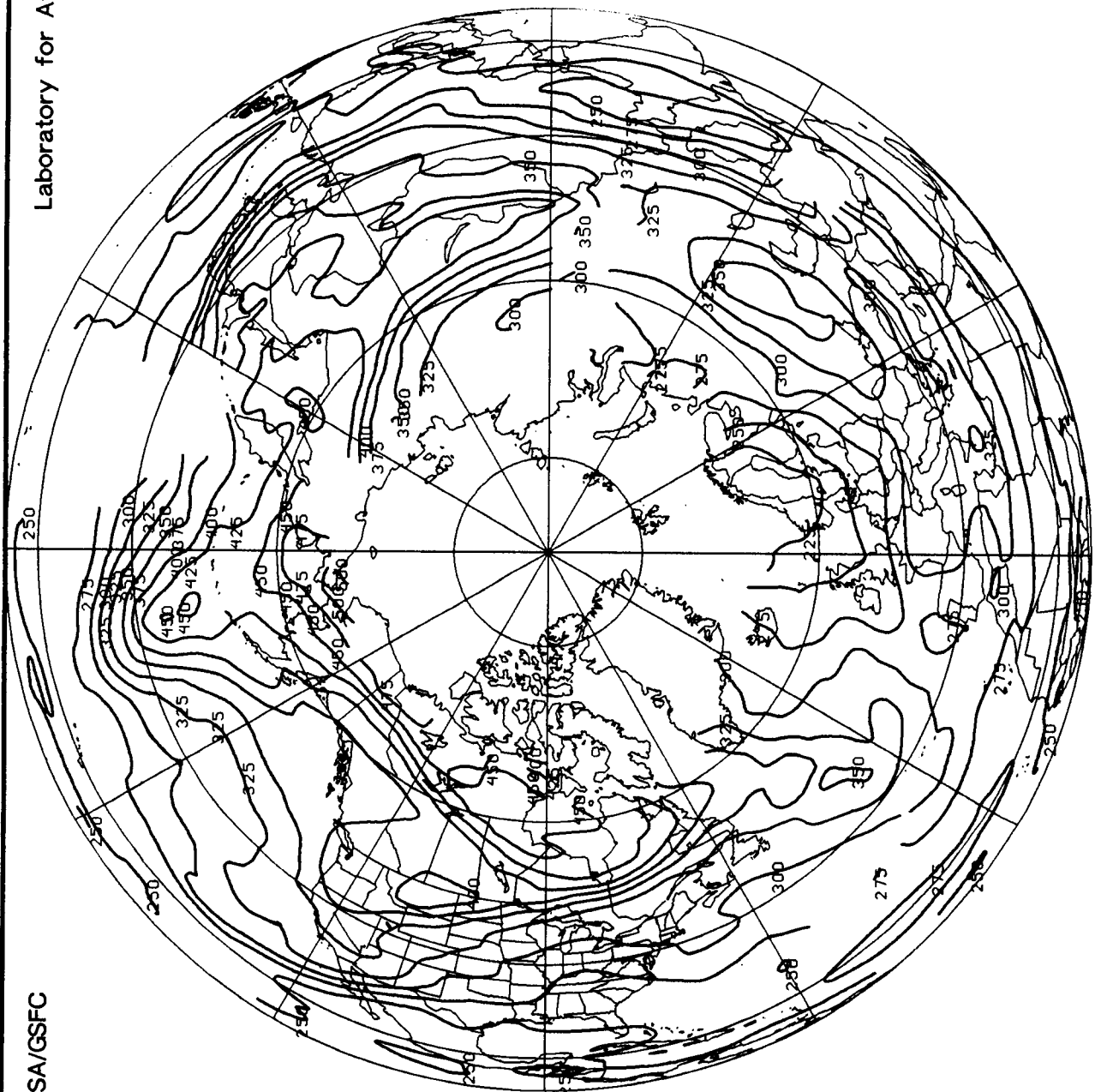
NASA/GSFC

Laboratory for Atmospheres



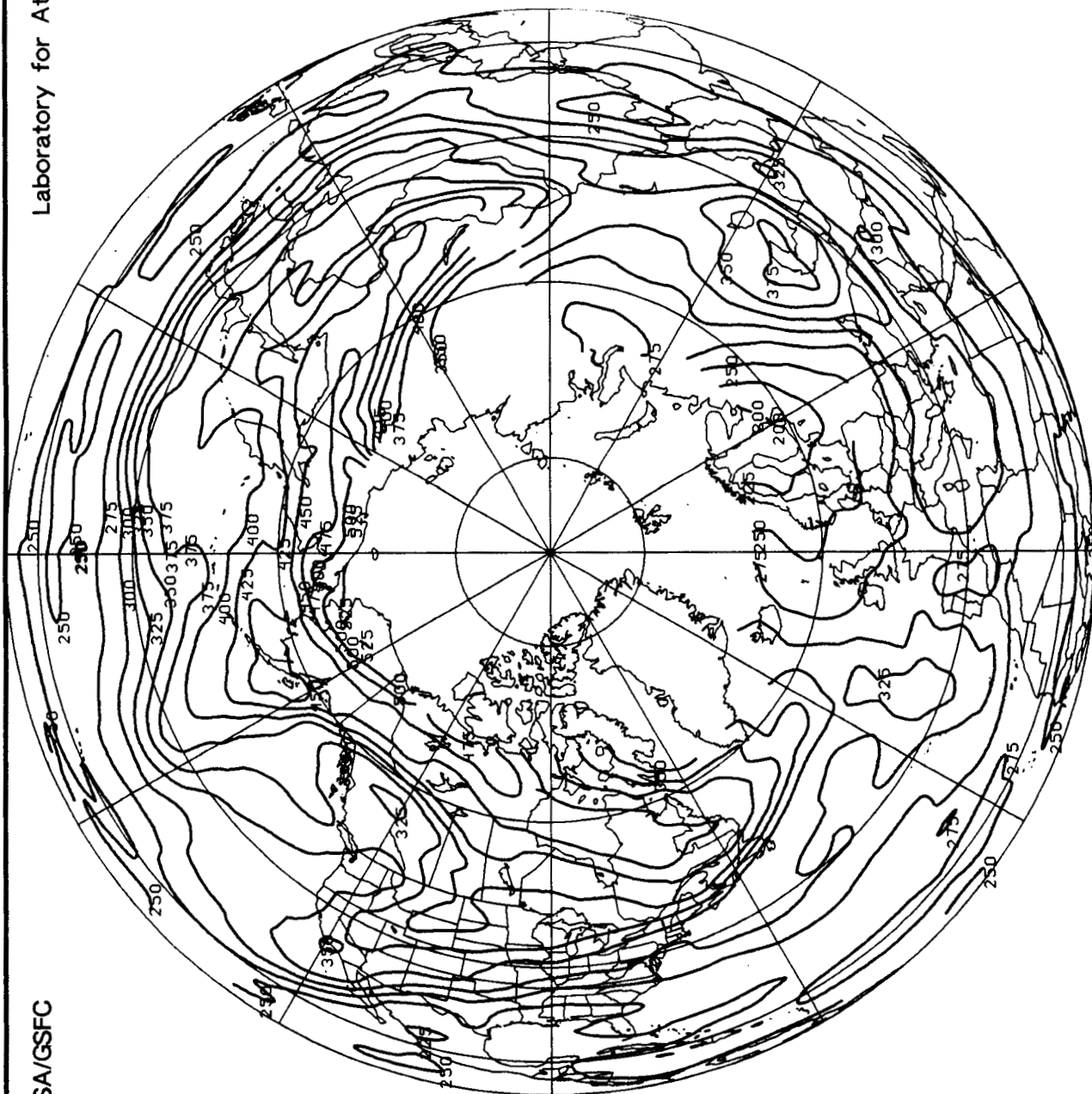
January 23, 1989

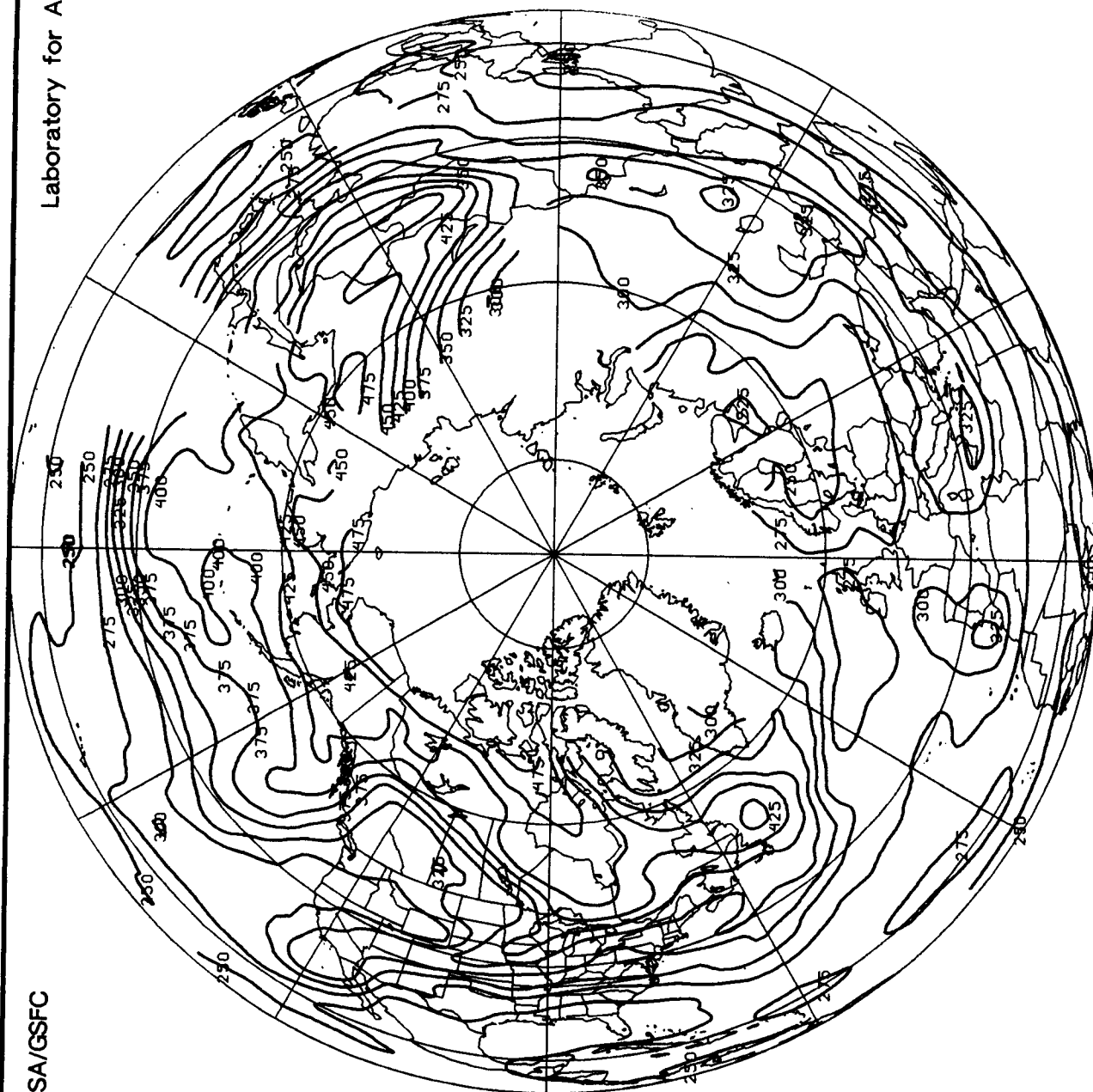
Gridded TOMS Ozone (Dobson Units)



January 24, 1989

Gridded TOMS Ozone (Dobson Units)



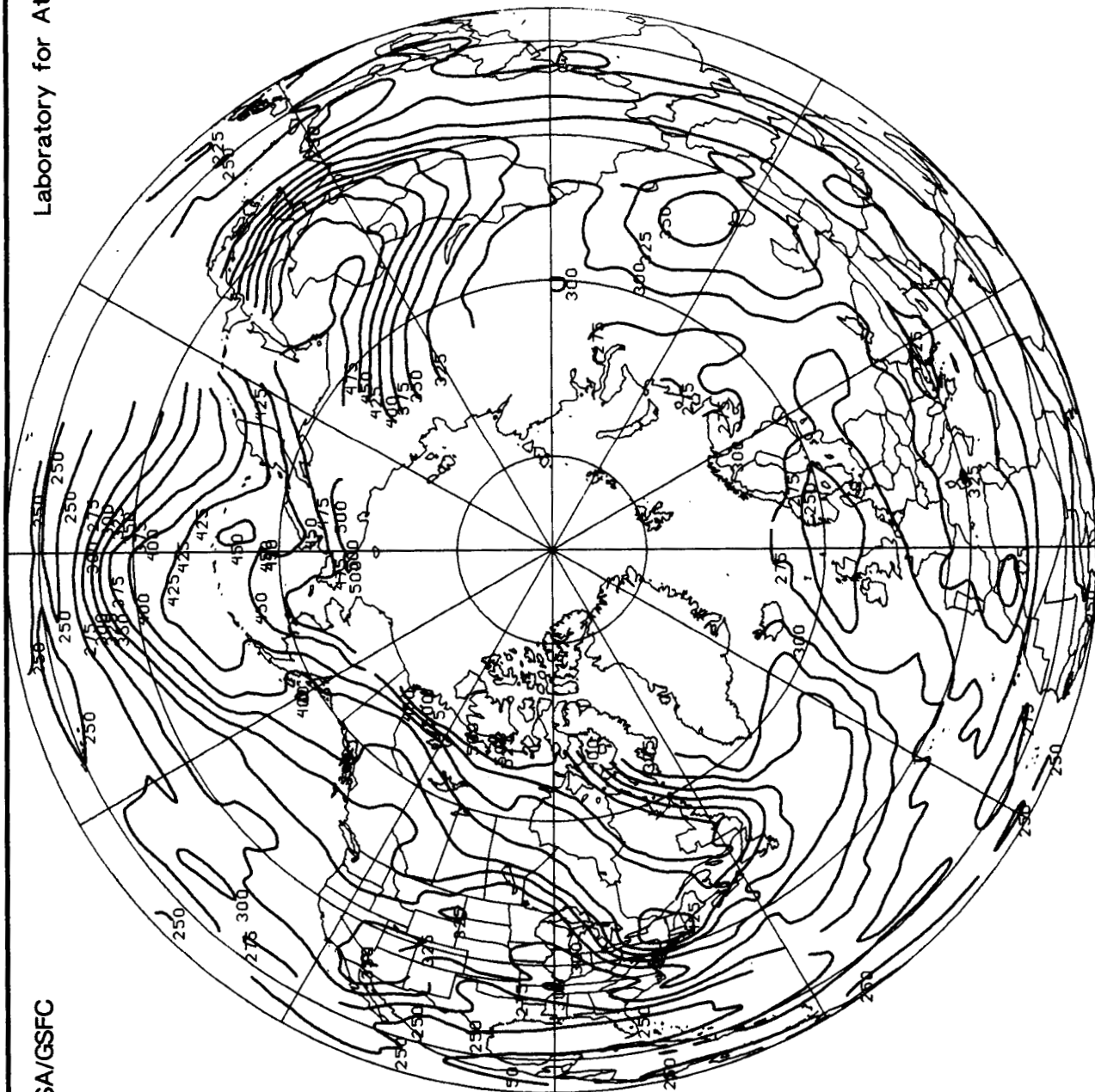


January 26, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

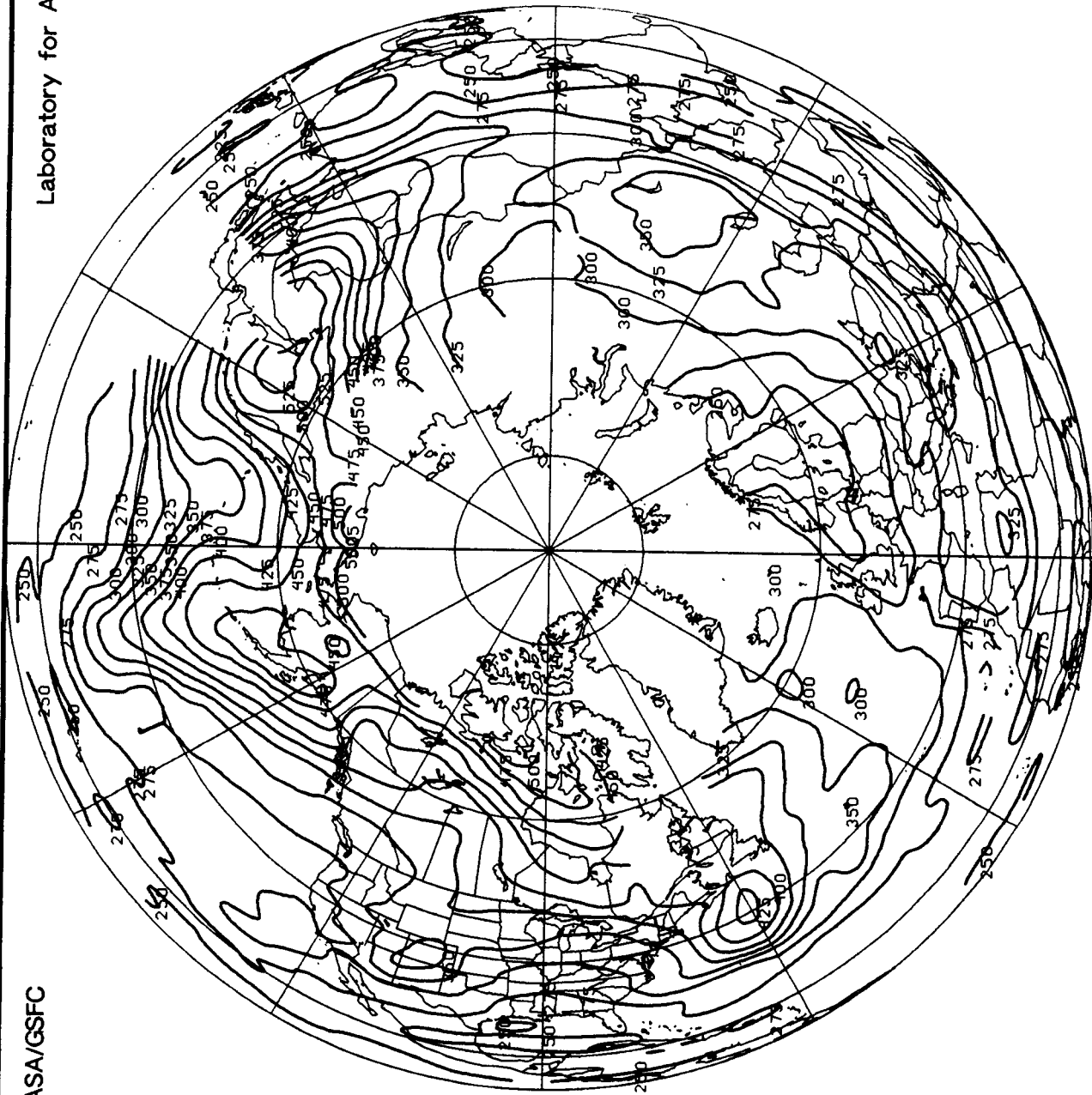


January 27, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

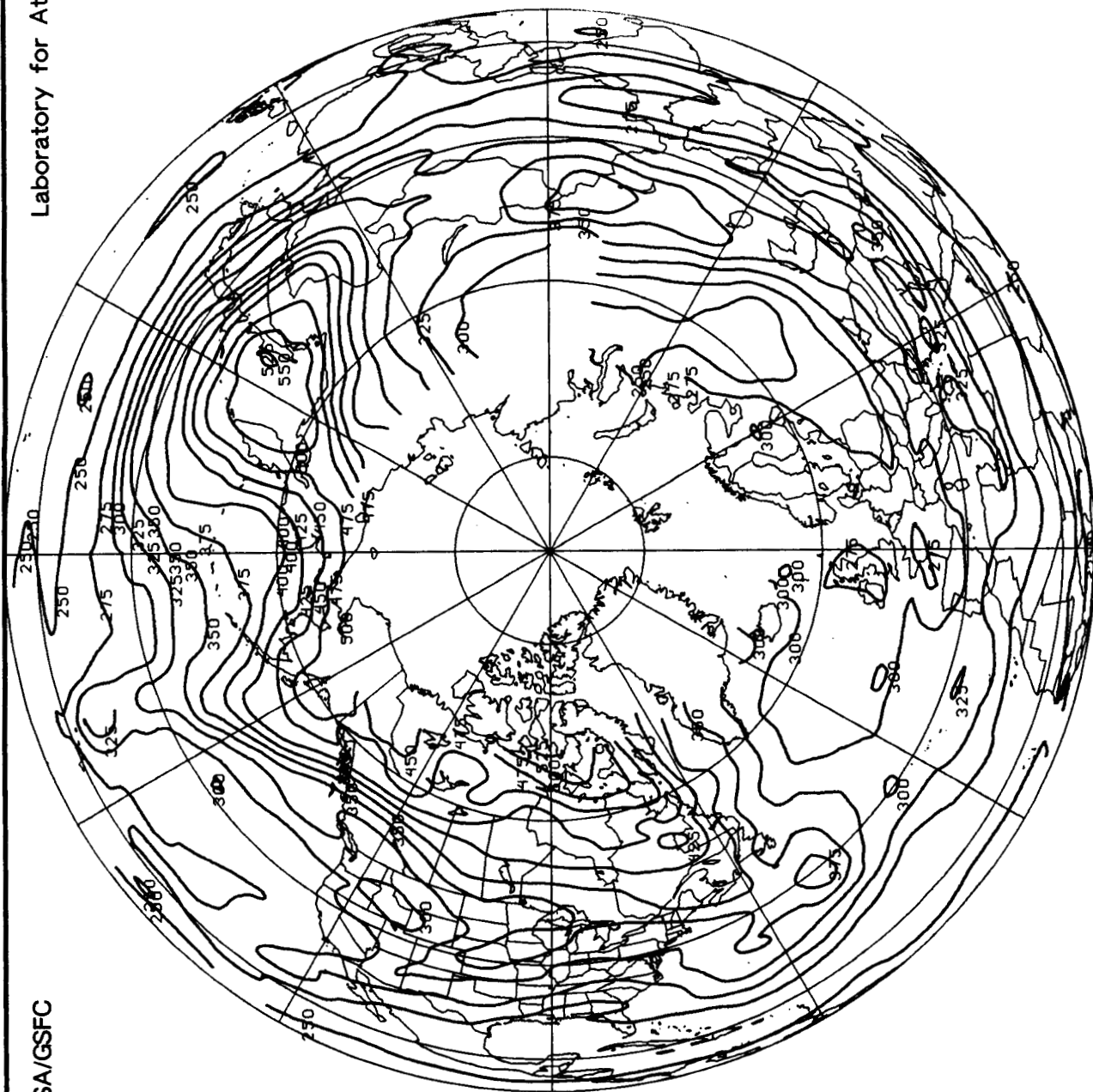


January 28, 1989

Gridded TOMS Ozone (Dobson Units)

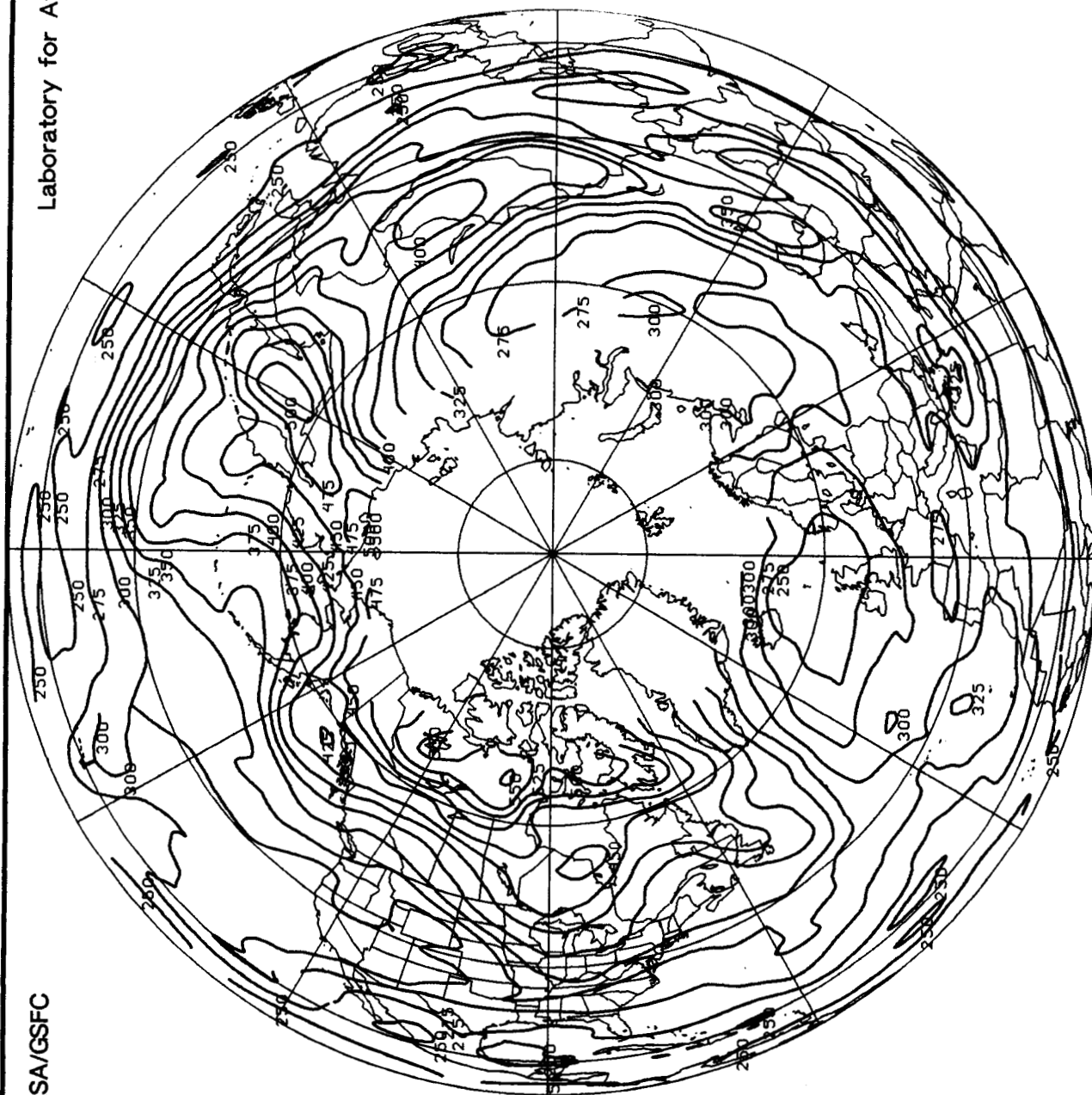
NASA/GSFC

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January 29, 1989

Gridded TOMS Ozone (Dobson Units)

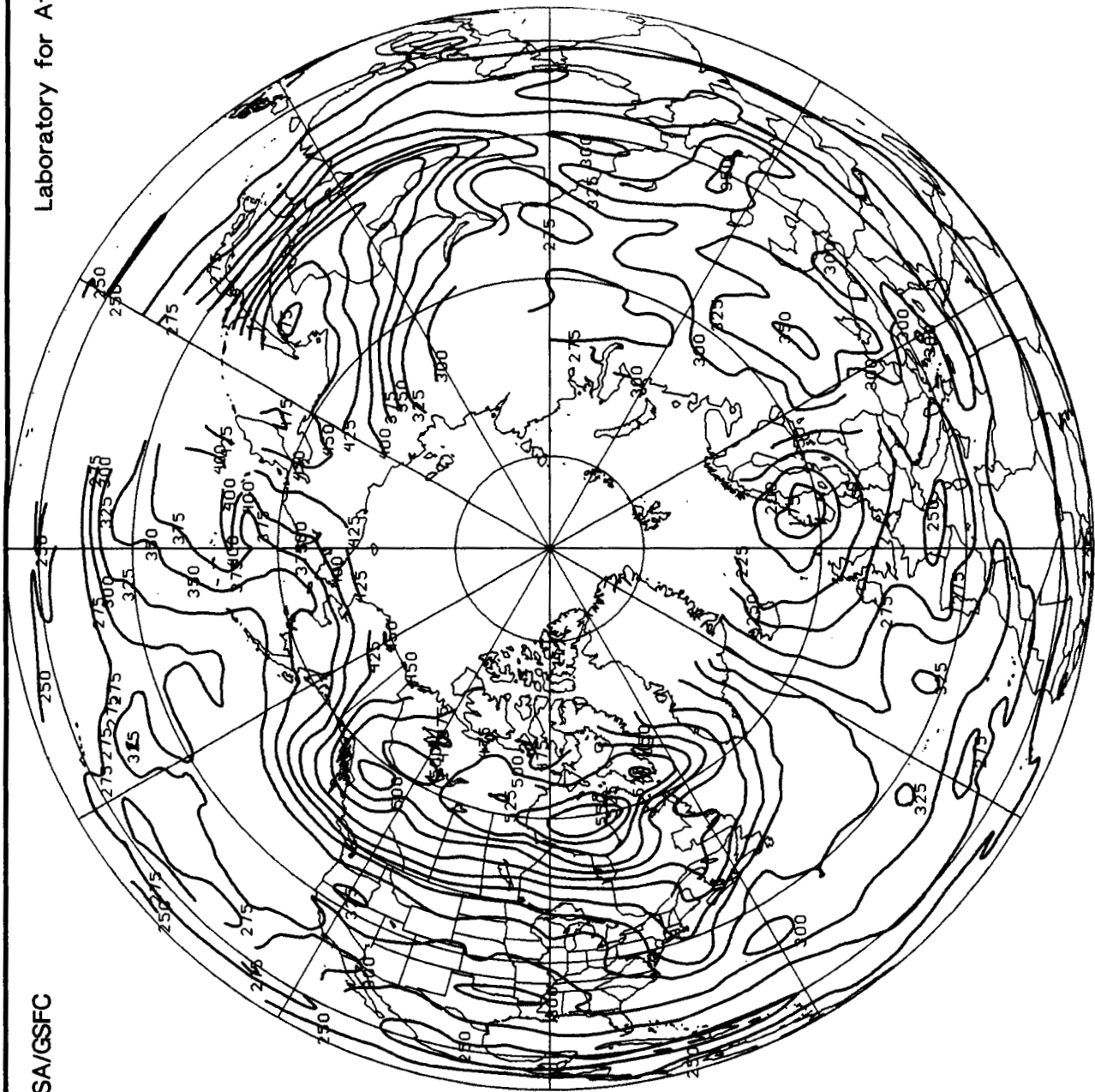


January 30, 1989

Gridded TOMS Ozone (Dobson Units)

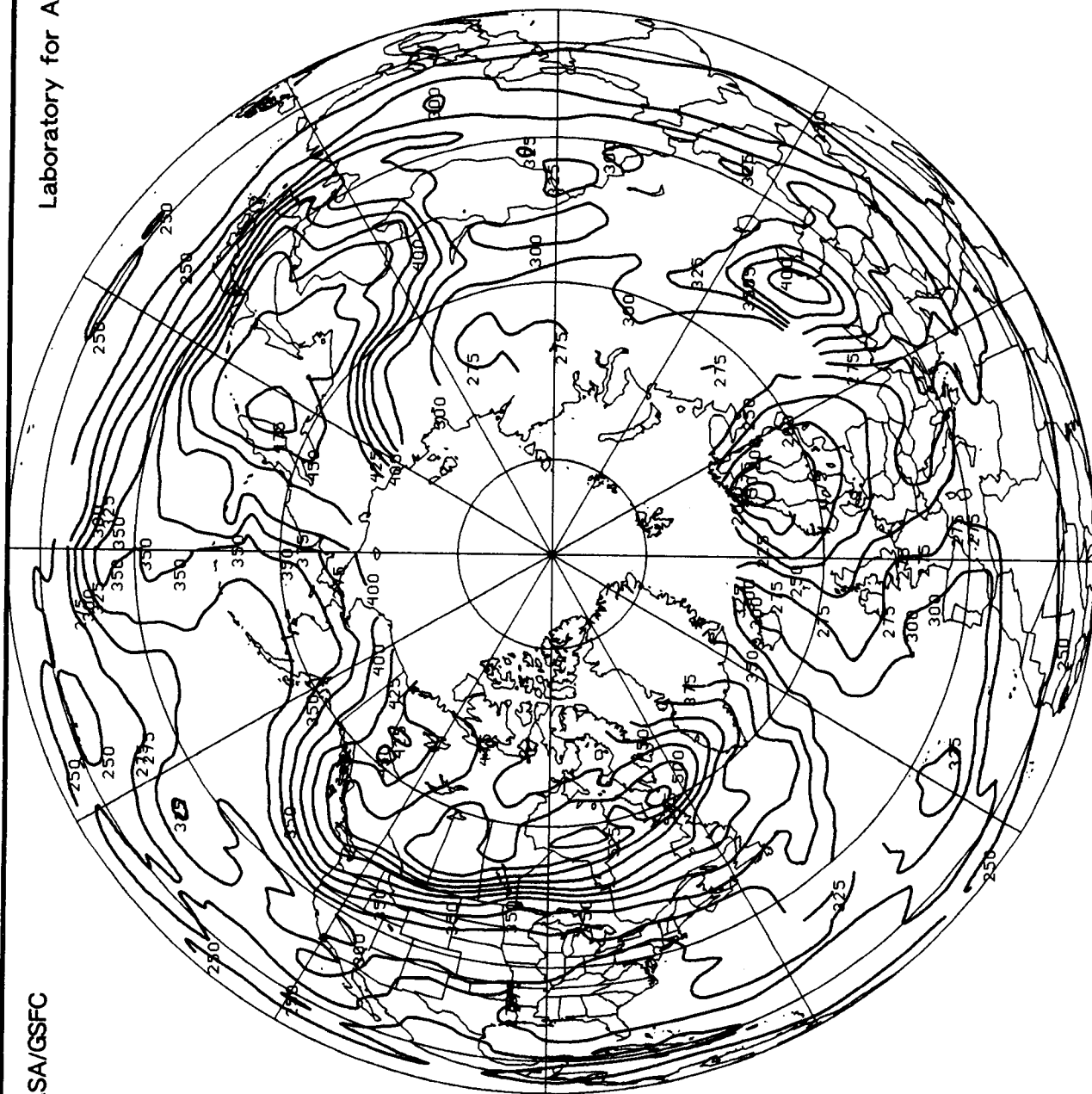
NASA/GSFC

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January 31, 1989

Gridded TOMS Ozone (Dobson Units)

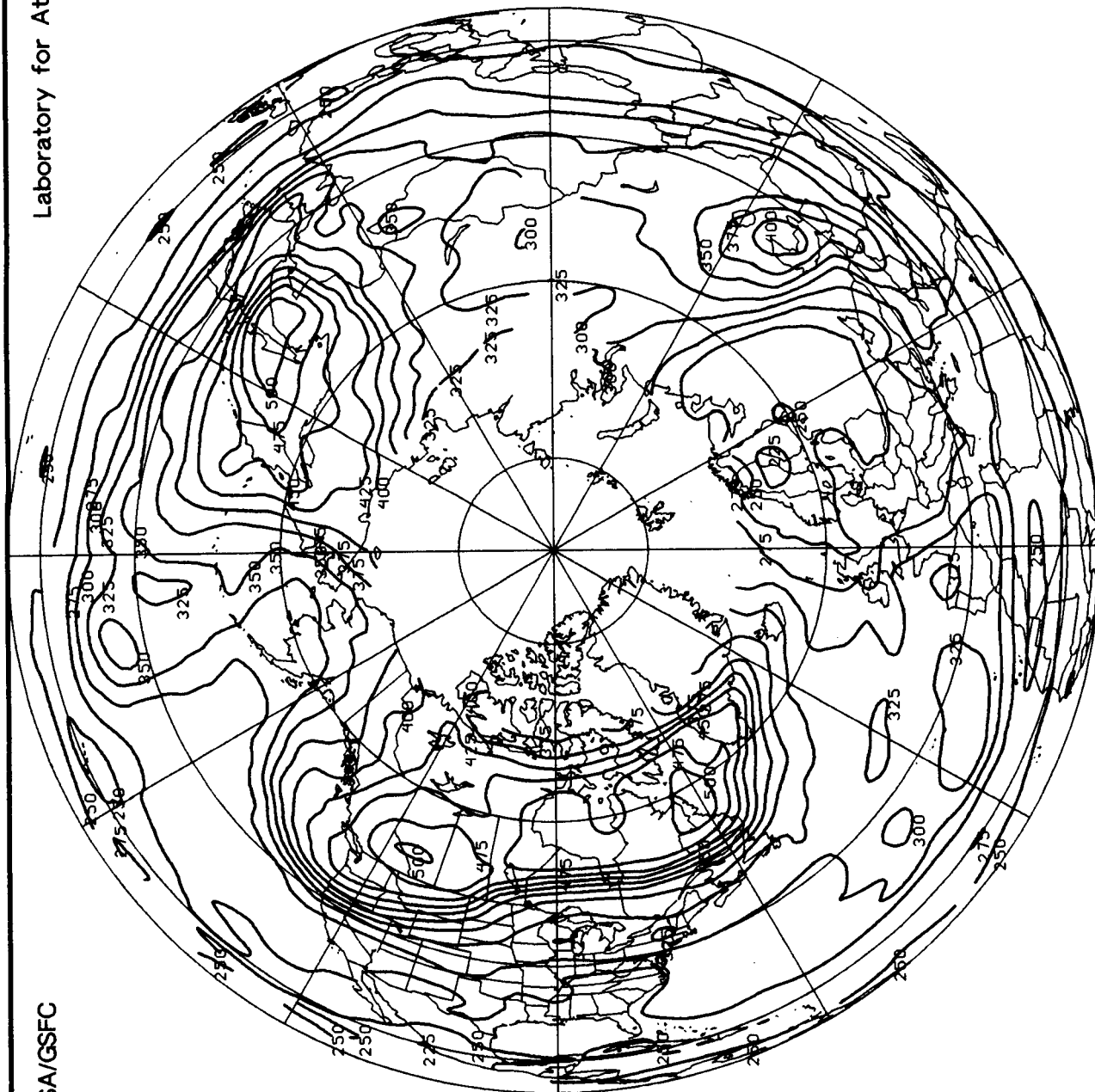


February 1, 1989

Gridded TOMS Ozone (Dobson Units)

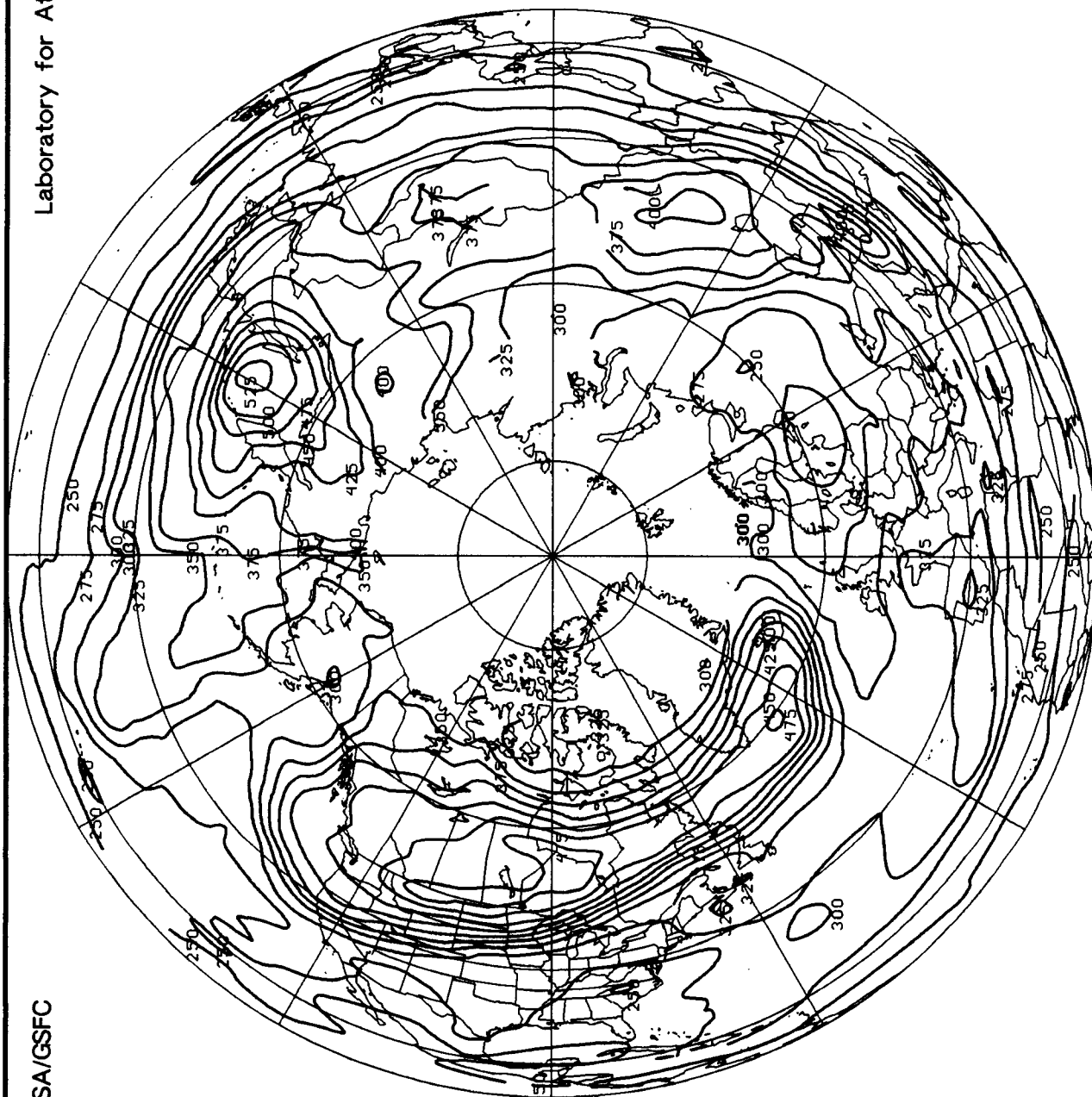
NASA/GSFC

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February 2, 1989

Gridded TOMS Ozone (Dobson Units)

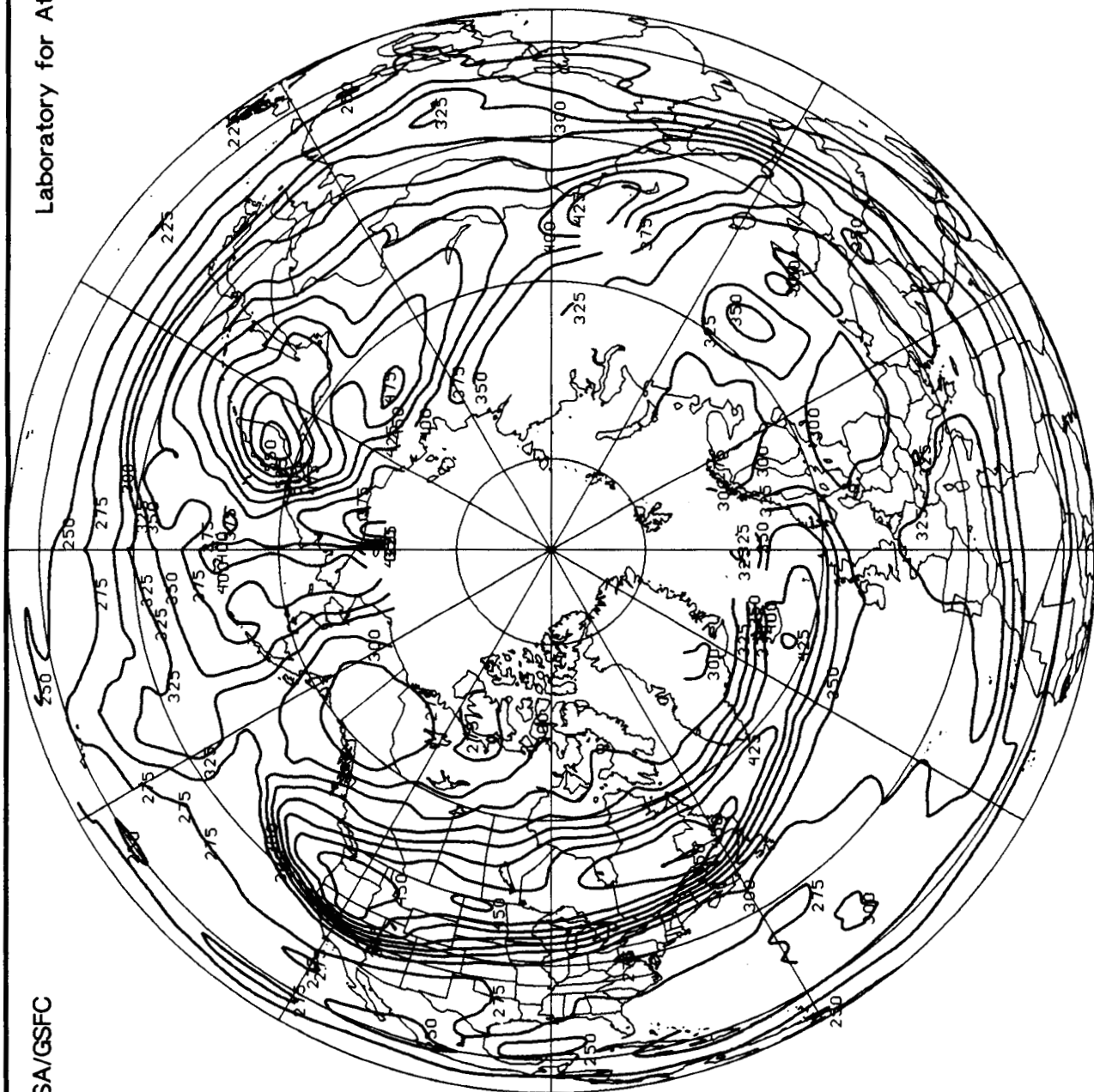


February 3, 1989

Gridded TOMS Ozone (Dobson Units)

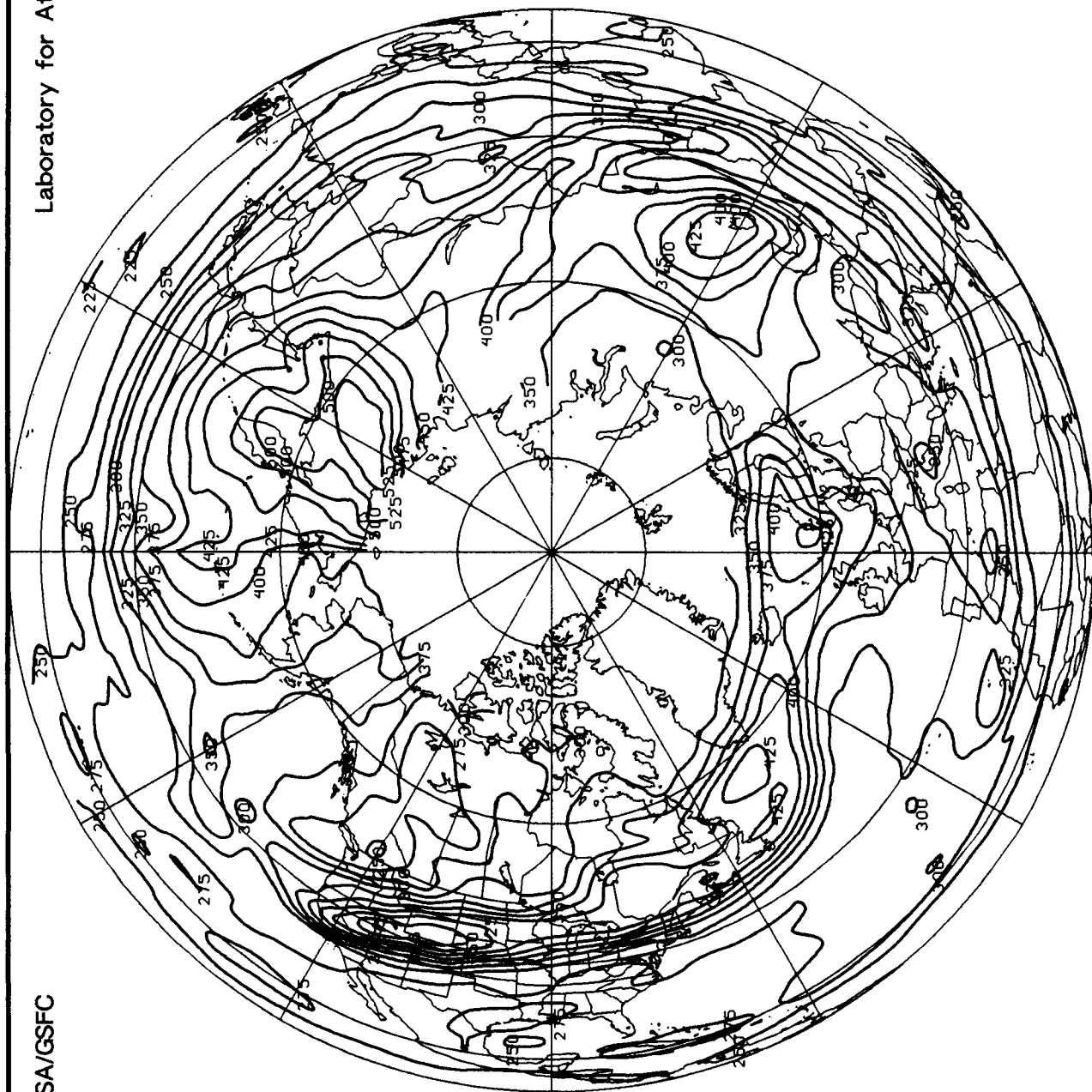
NASA/GSFC

Laboratory for Atmospheres



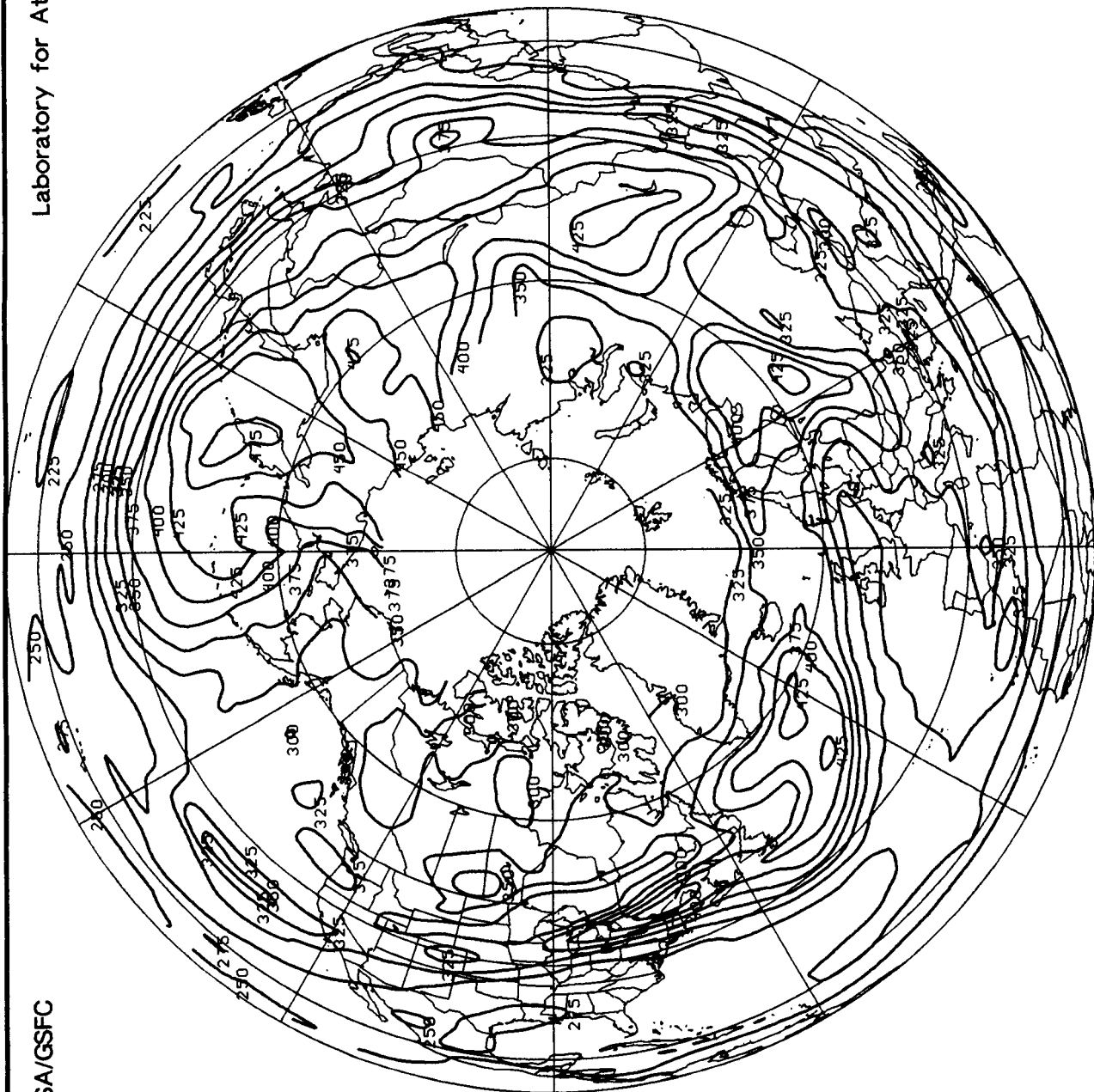
February 4, 1989

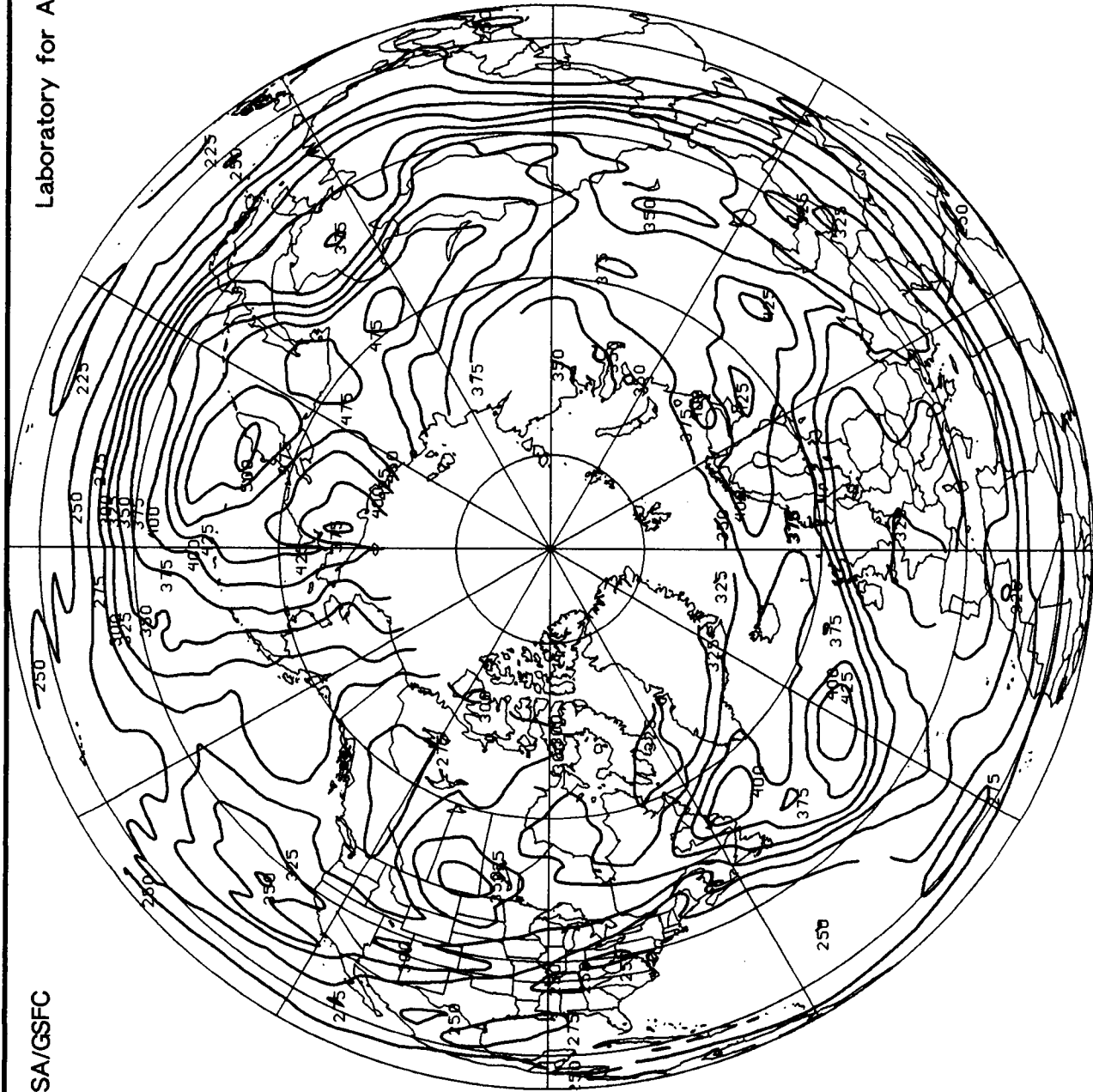
Gridded TOMS Ozone (Dobson Units)



February 5, 1989

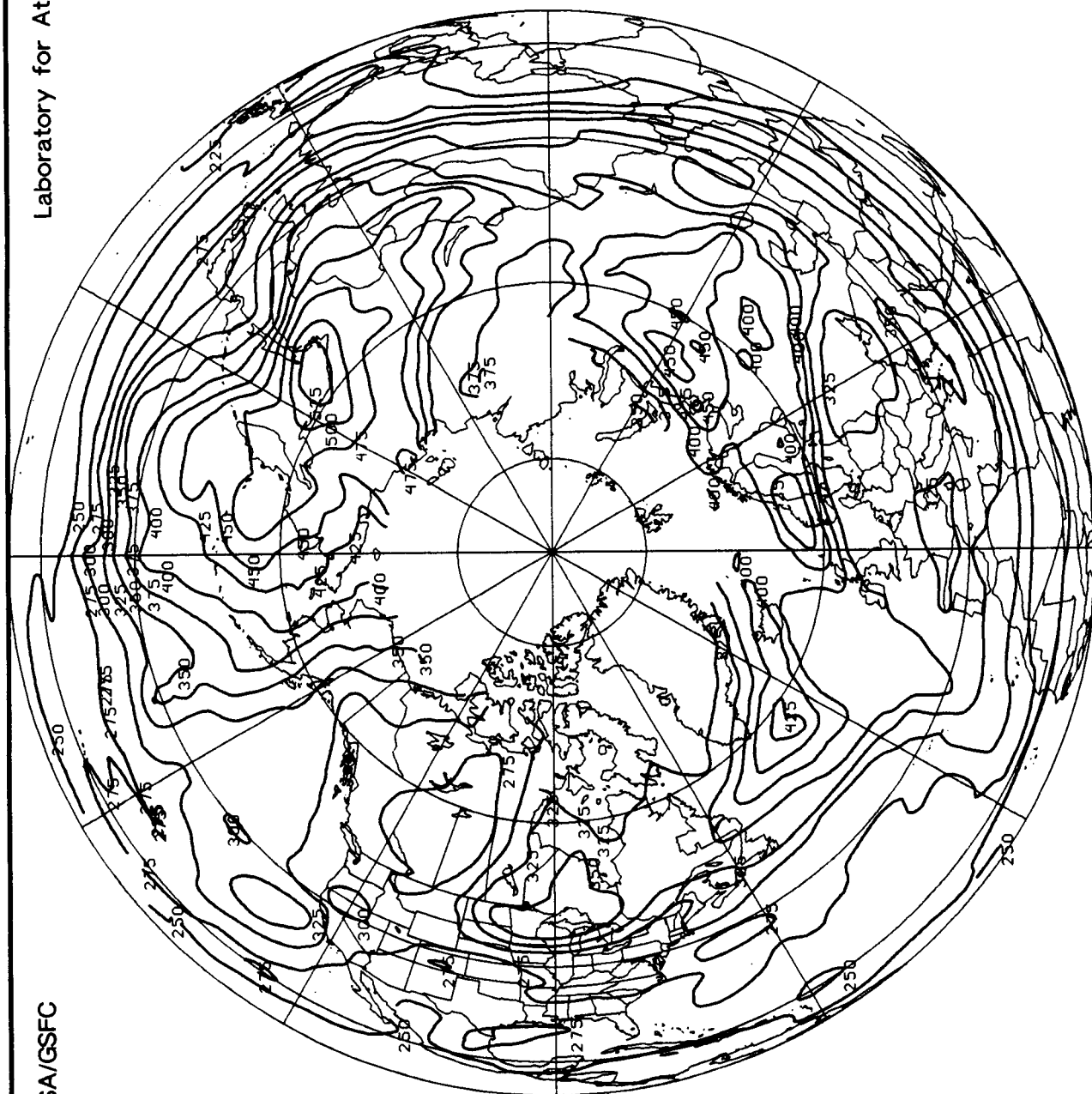
Gridded TOMS Ozone (Dobson Units)

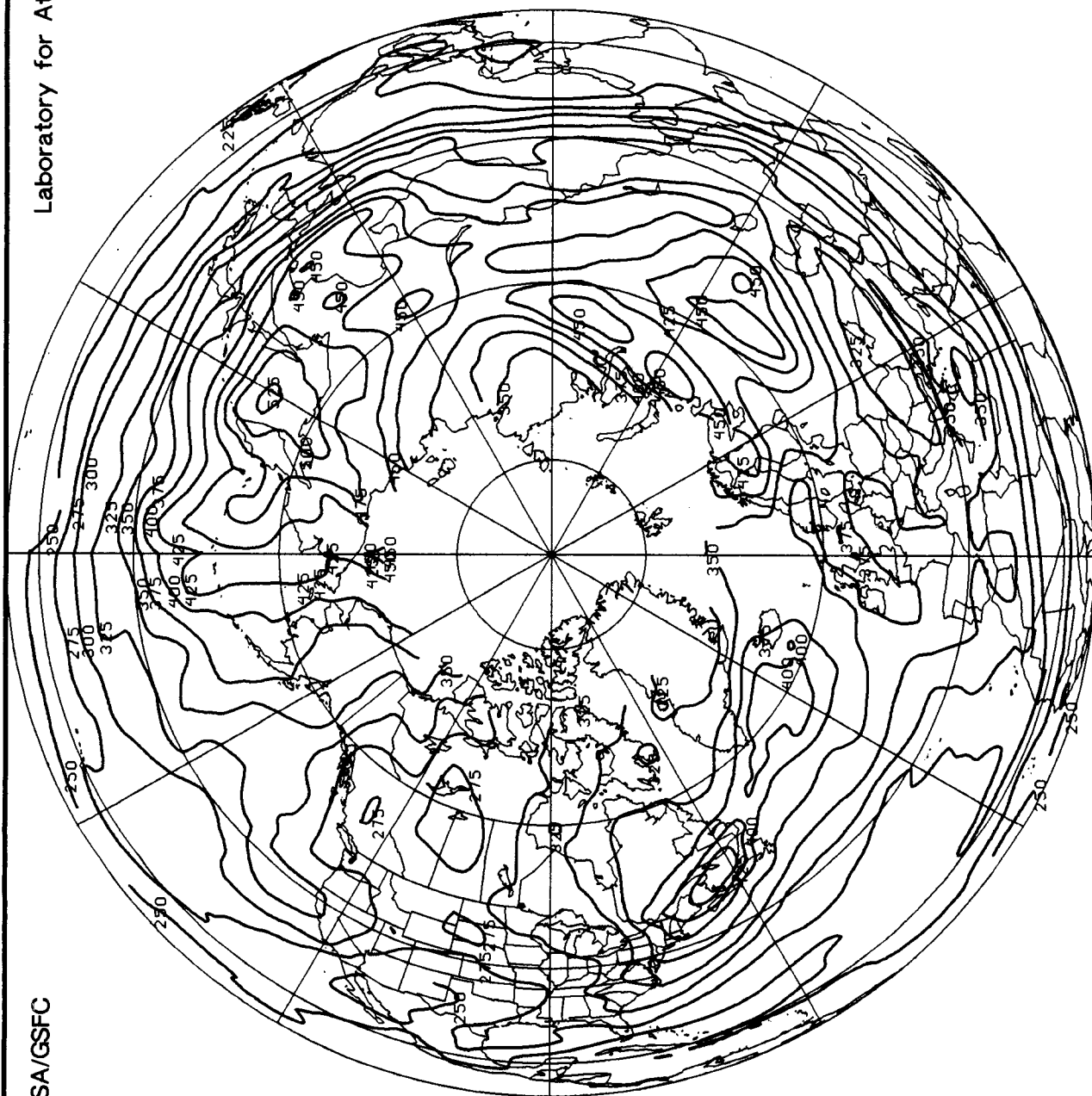




February 7, 1989

Gridded TOMS Ozone (Dobson Units)



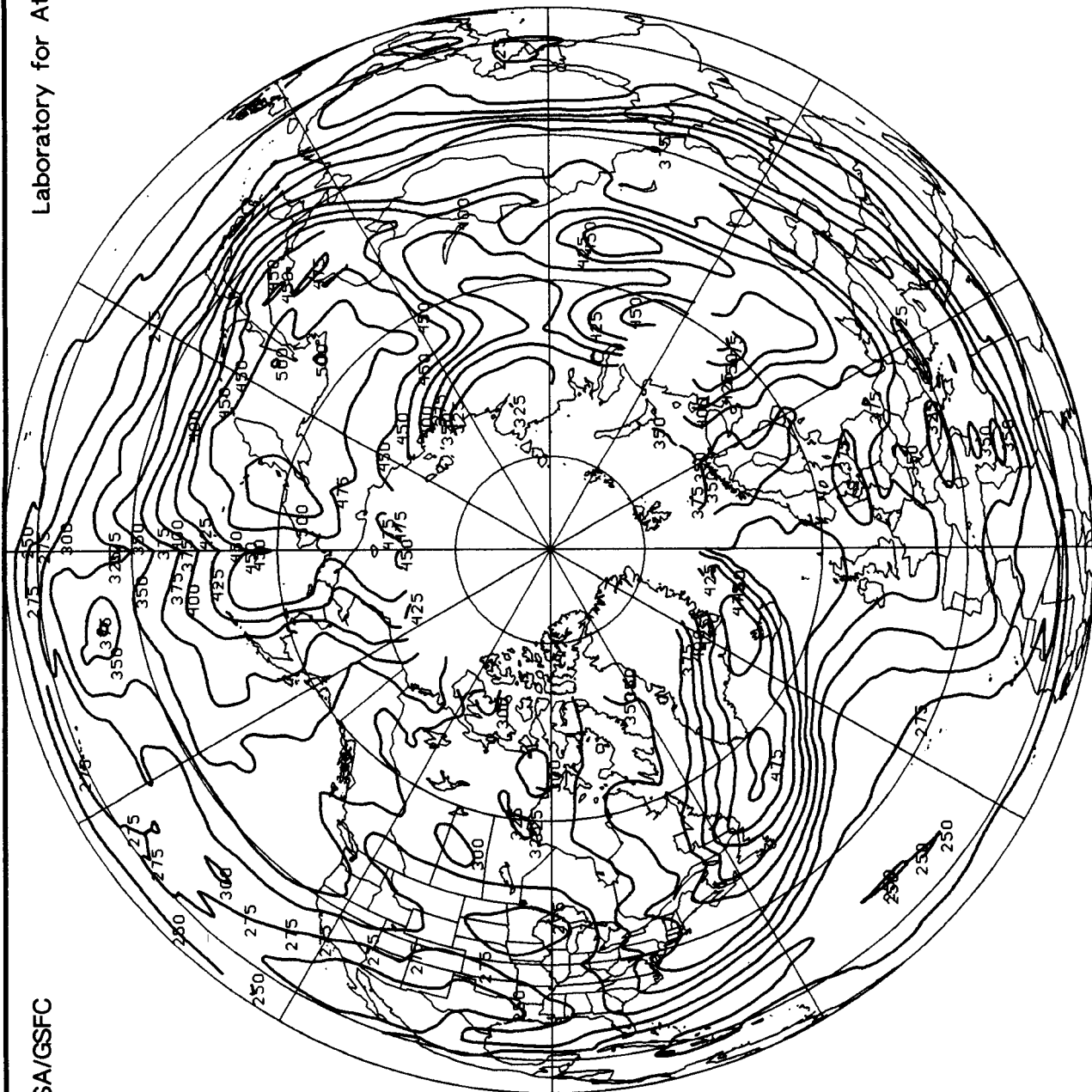


February 9, 1989

Gridded TOMS Ozone (Dobson Units)

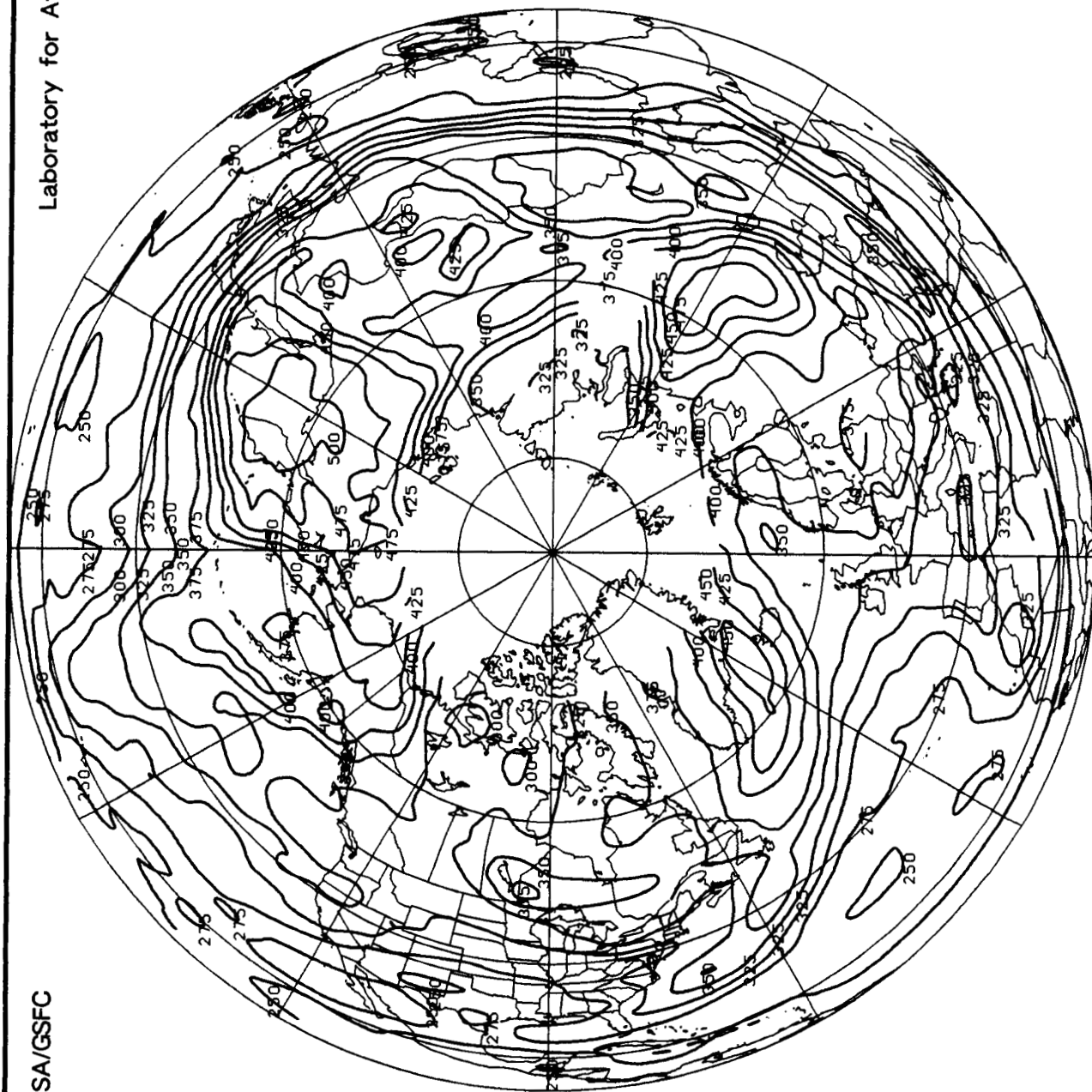
NASA/GSFC

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February 10, 1989

Gridded TOMS Ozone (Dobson Units)

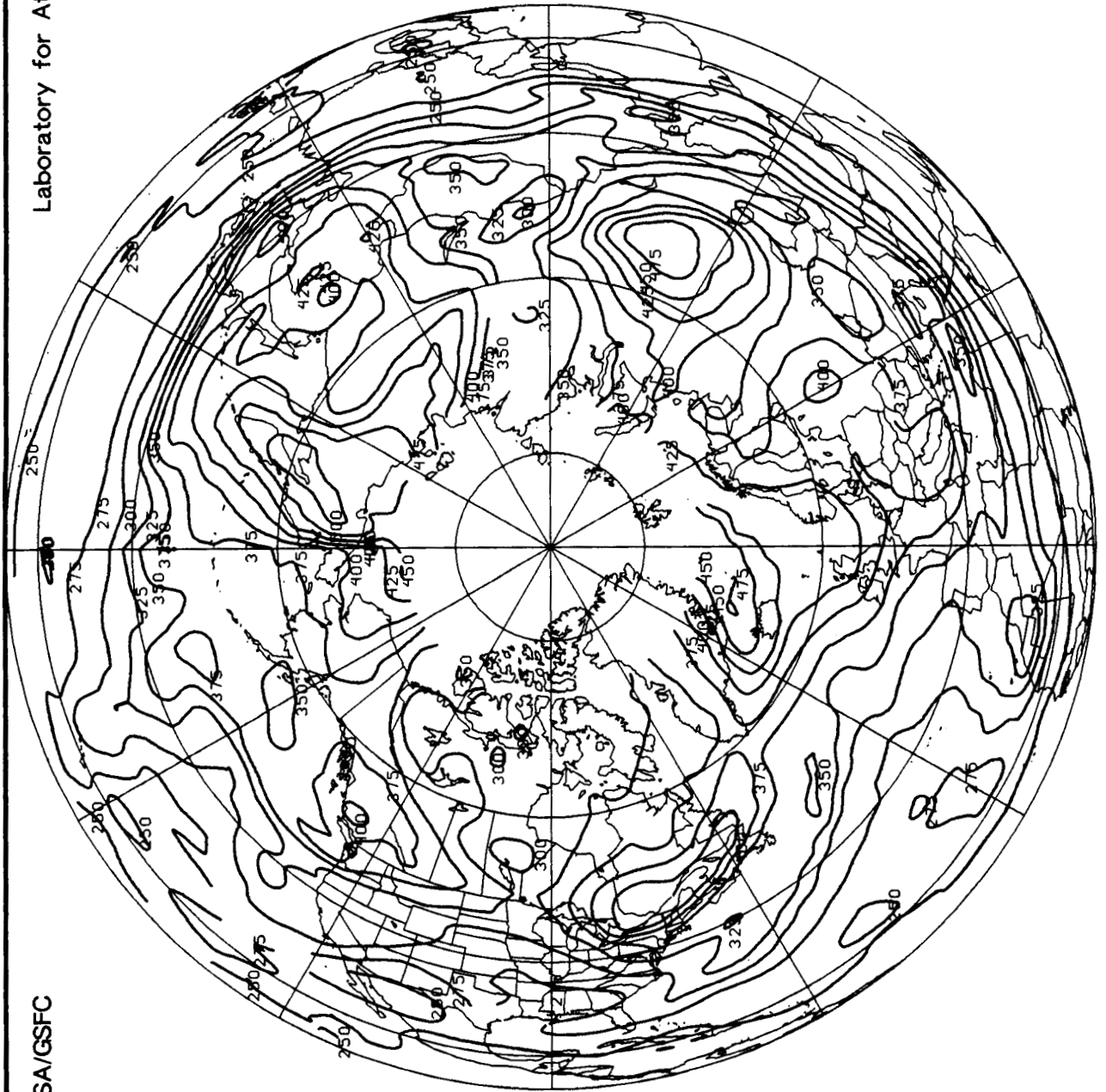


February 11, 1989

Gridded TOMS Ozone (Dobson Units)

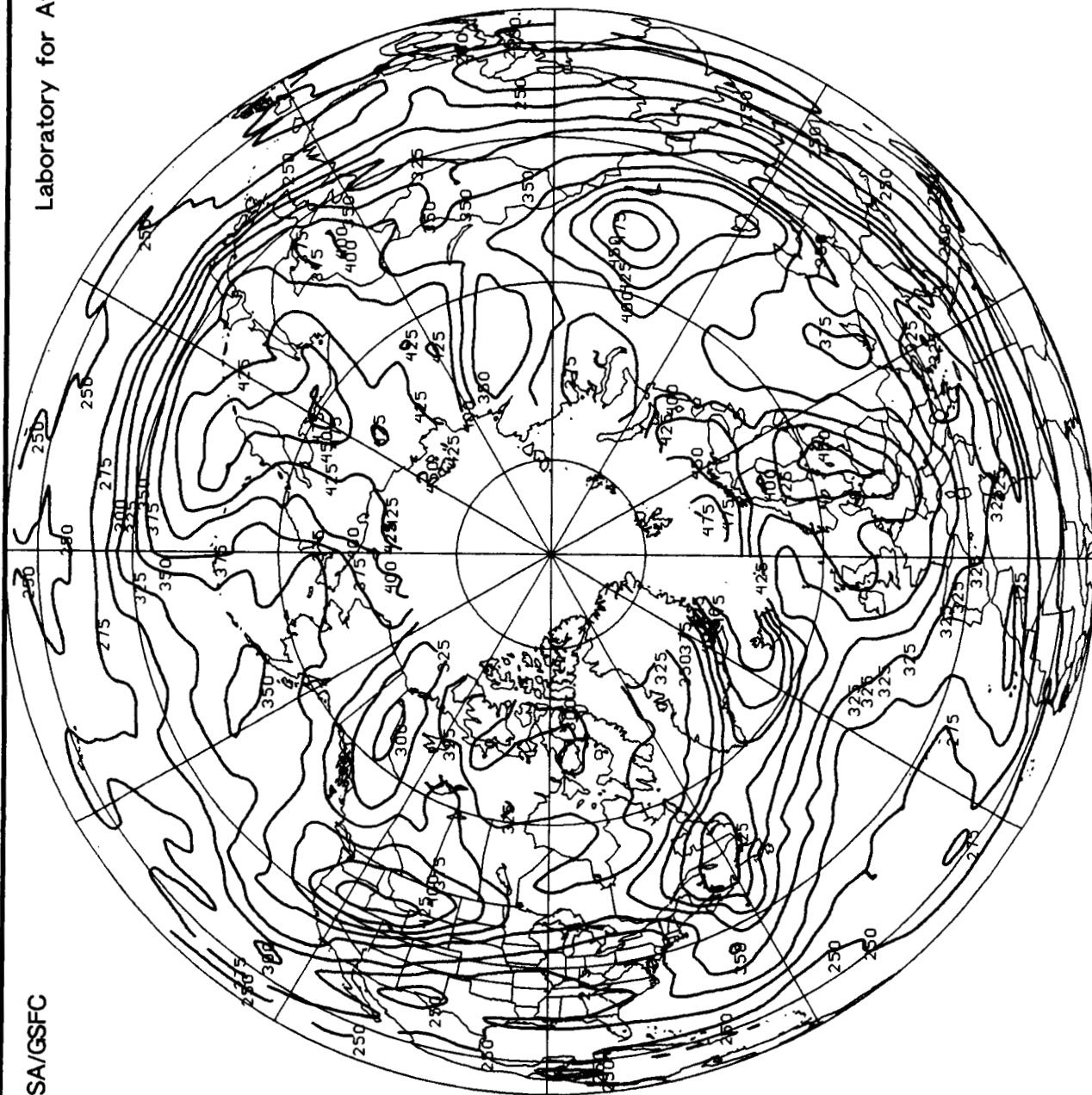
NASA/GSFC

Laboratory for Atmospheres



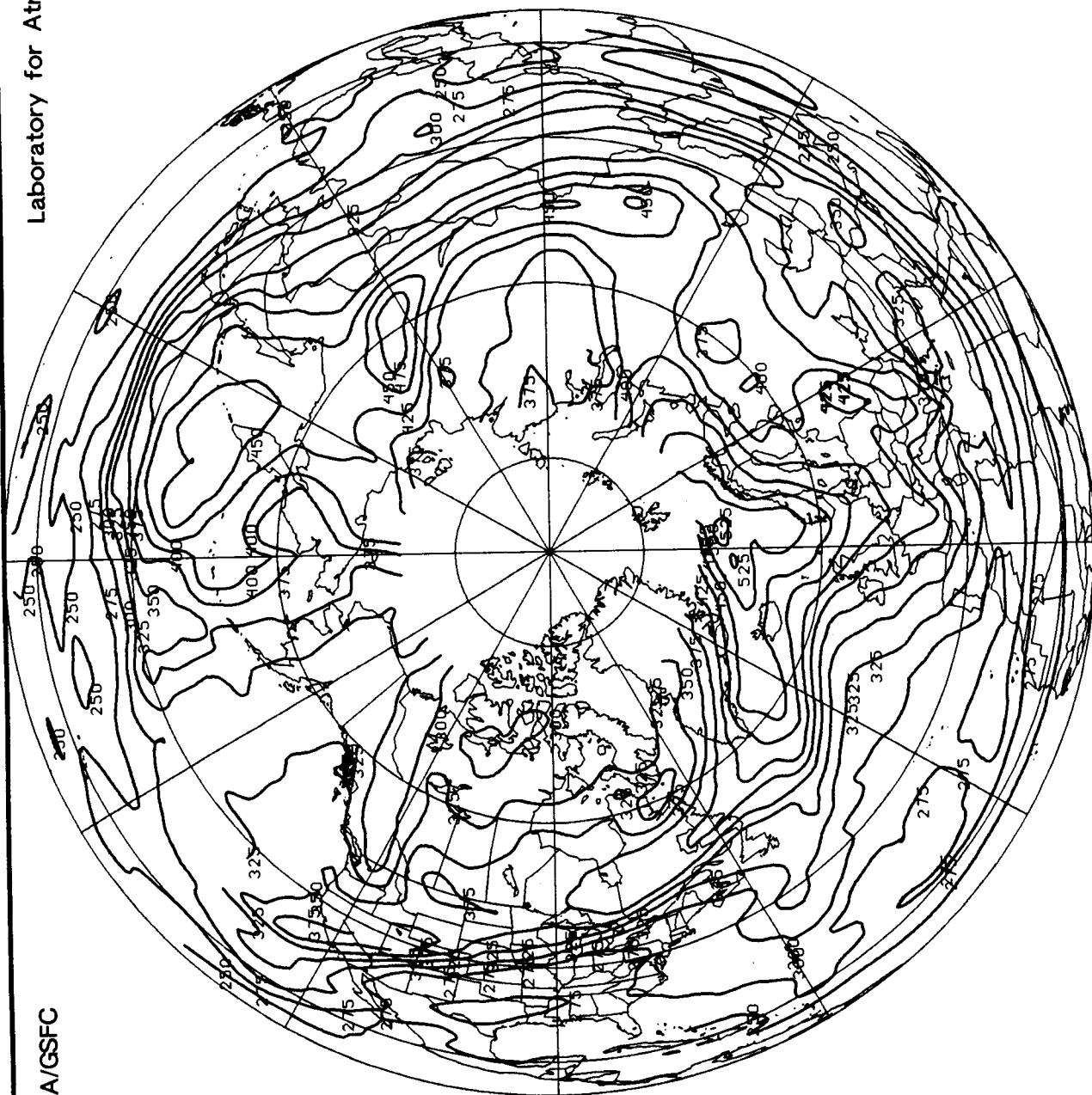
February 12, 1989

Gridded TOMS Ozone (Dobson Units)



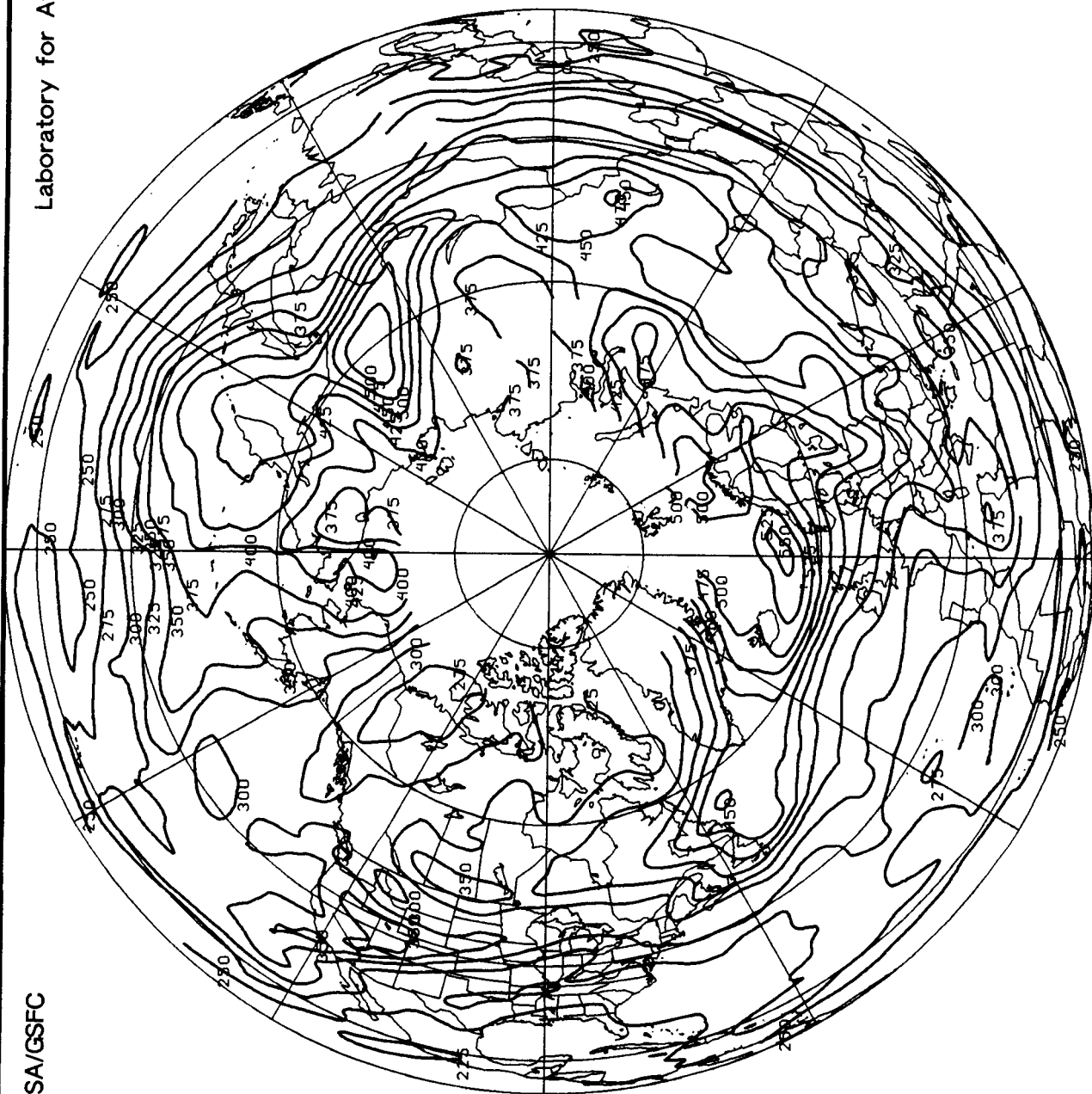
February 13, 1989

Gridded TOMS Ozone (Dobson Units)



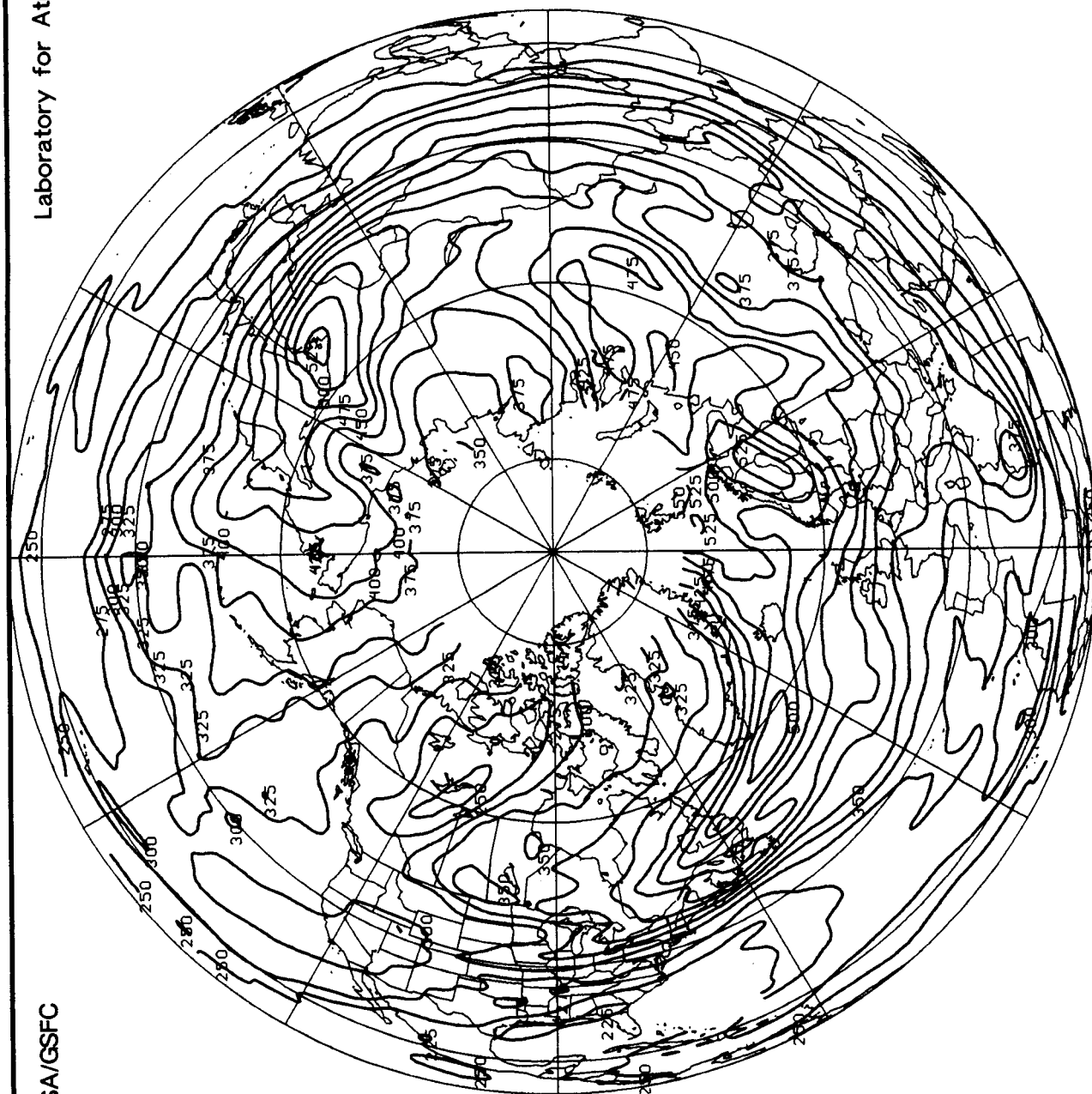
NASA/GSFC

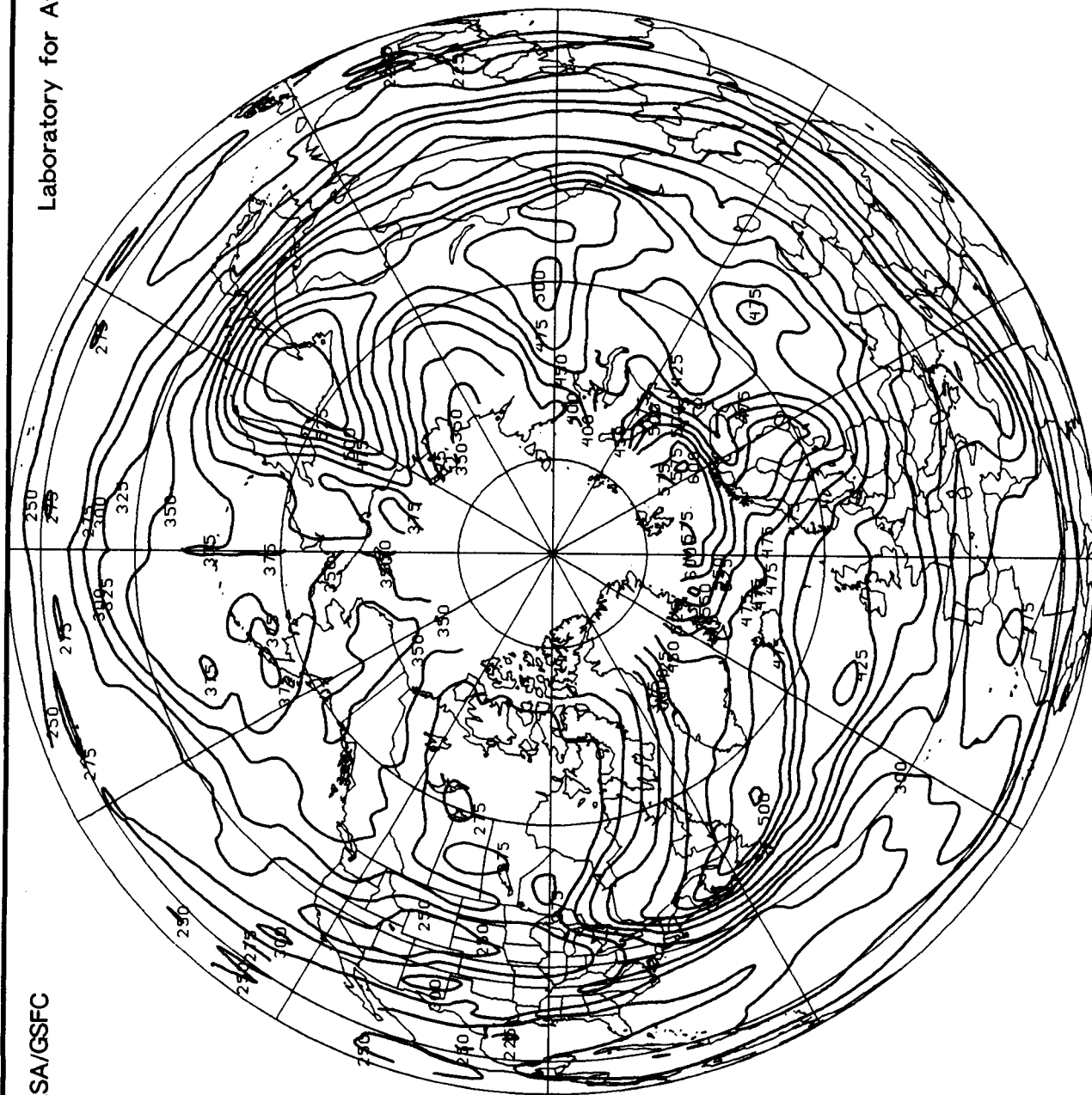
Laboratory for Atmospheres



February 15, 1989

Gridded TOMS Ozone (Dobson Units)



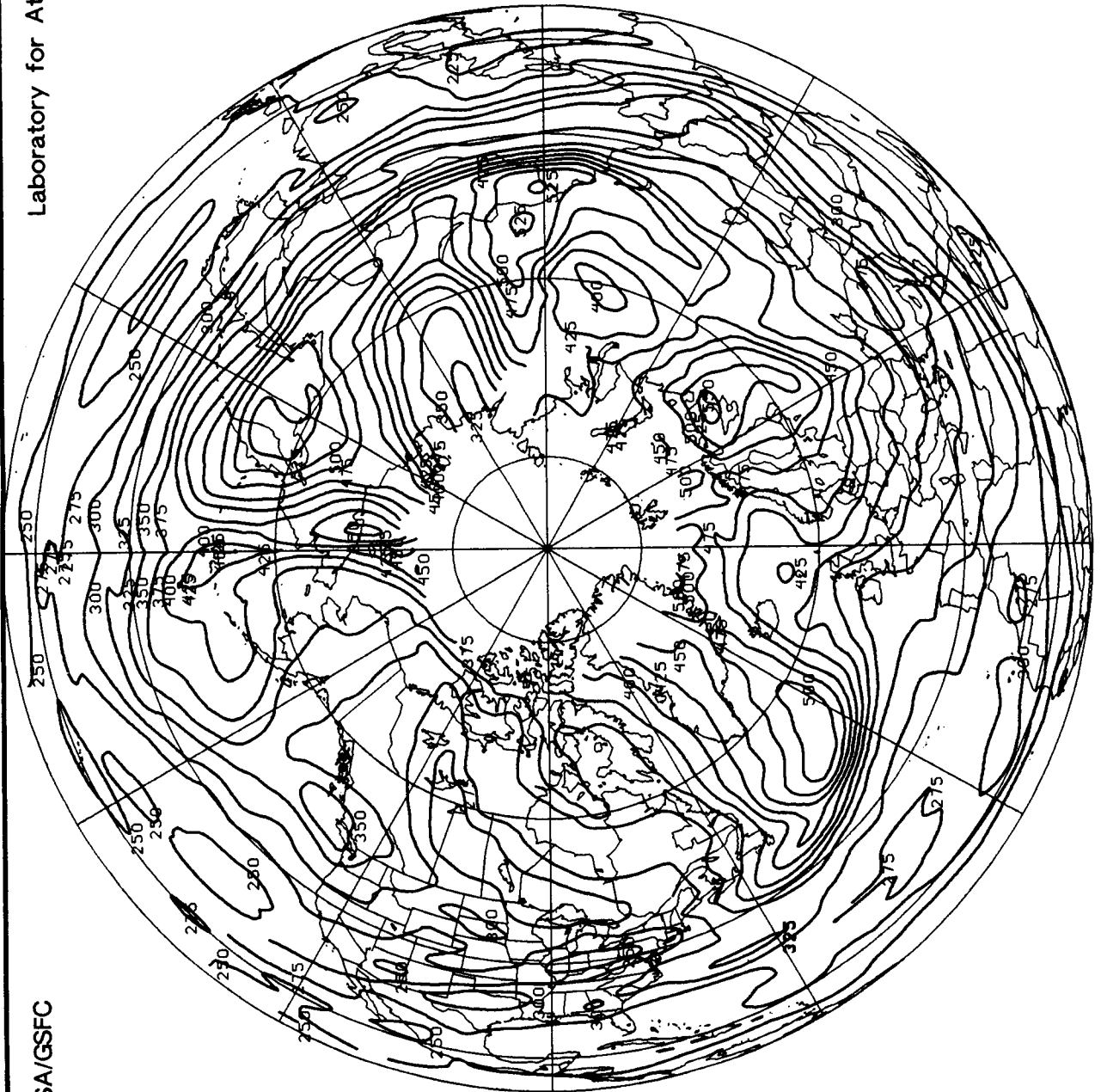


February 17, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

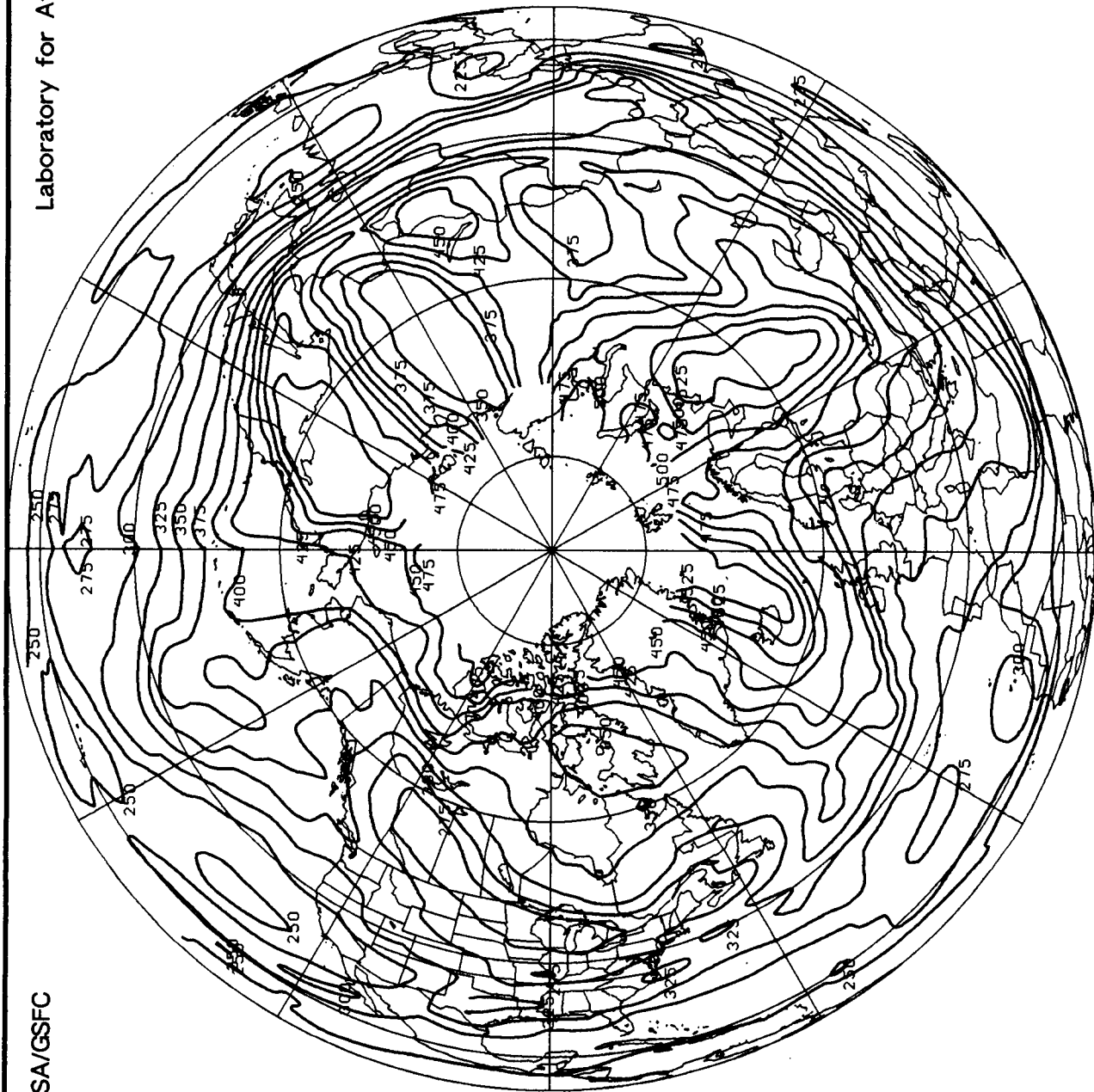


February 18, 1989

Gridded TOMS Ozone (Dobson Units)

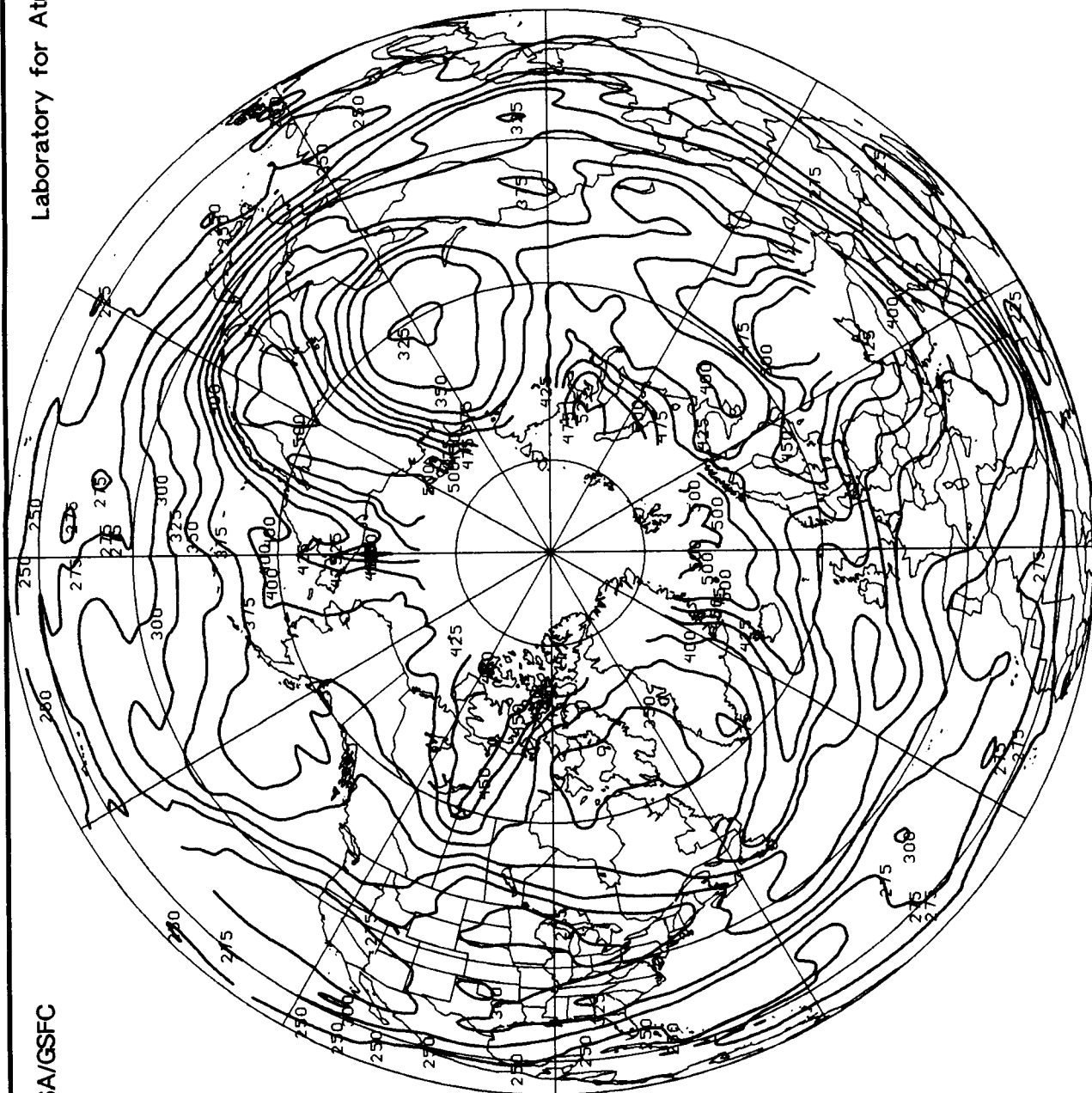
NASA/GSFC

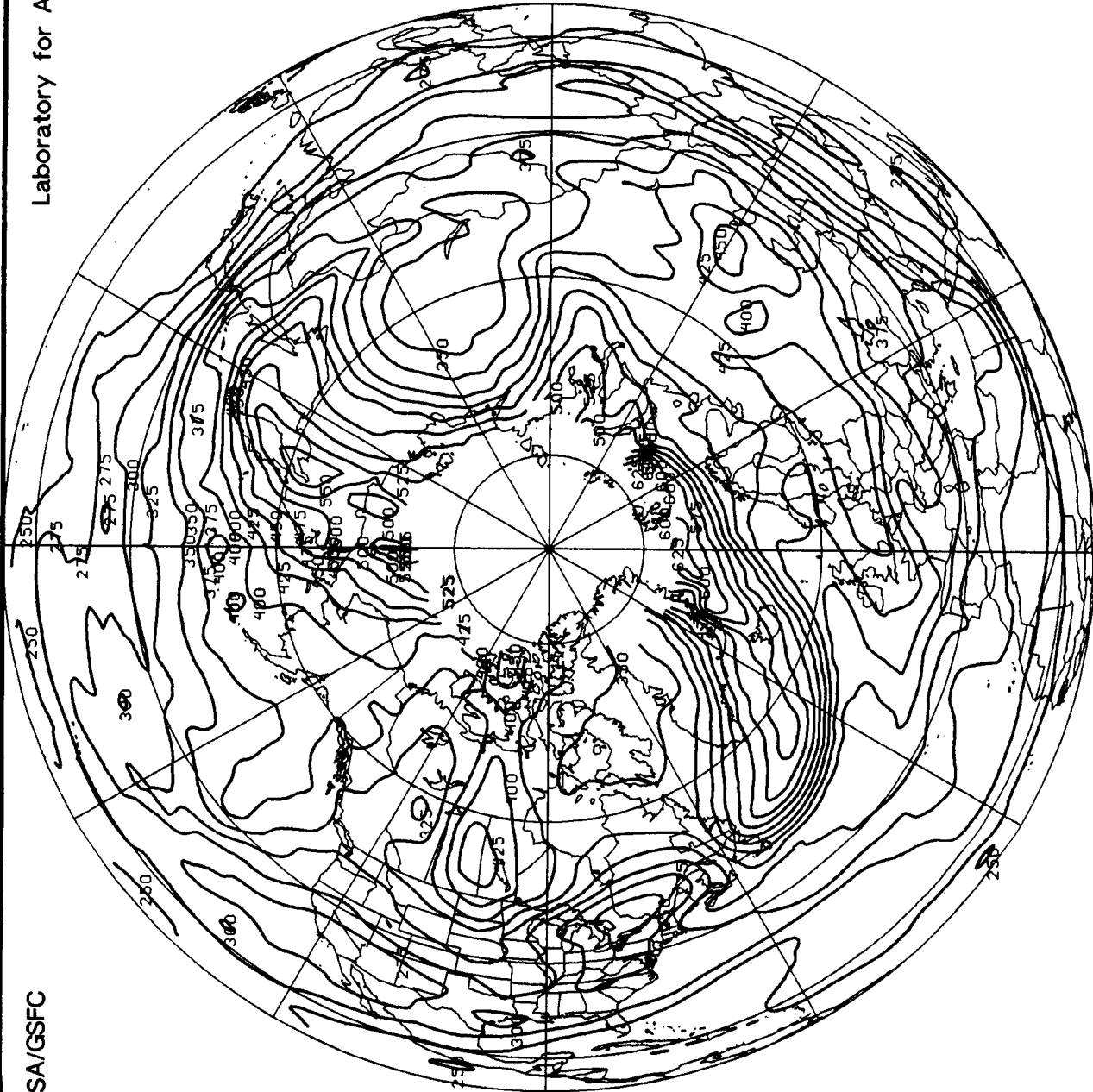
Laboratory for Atmospheres



February 19, 1989

Gridded TOMS Ozone (Dobson Units)



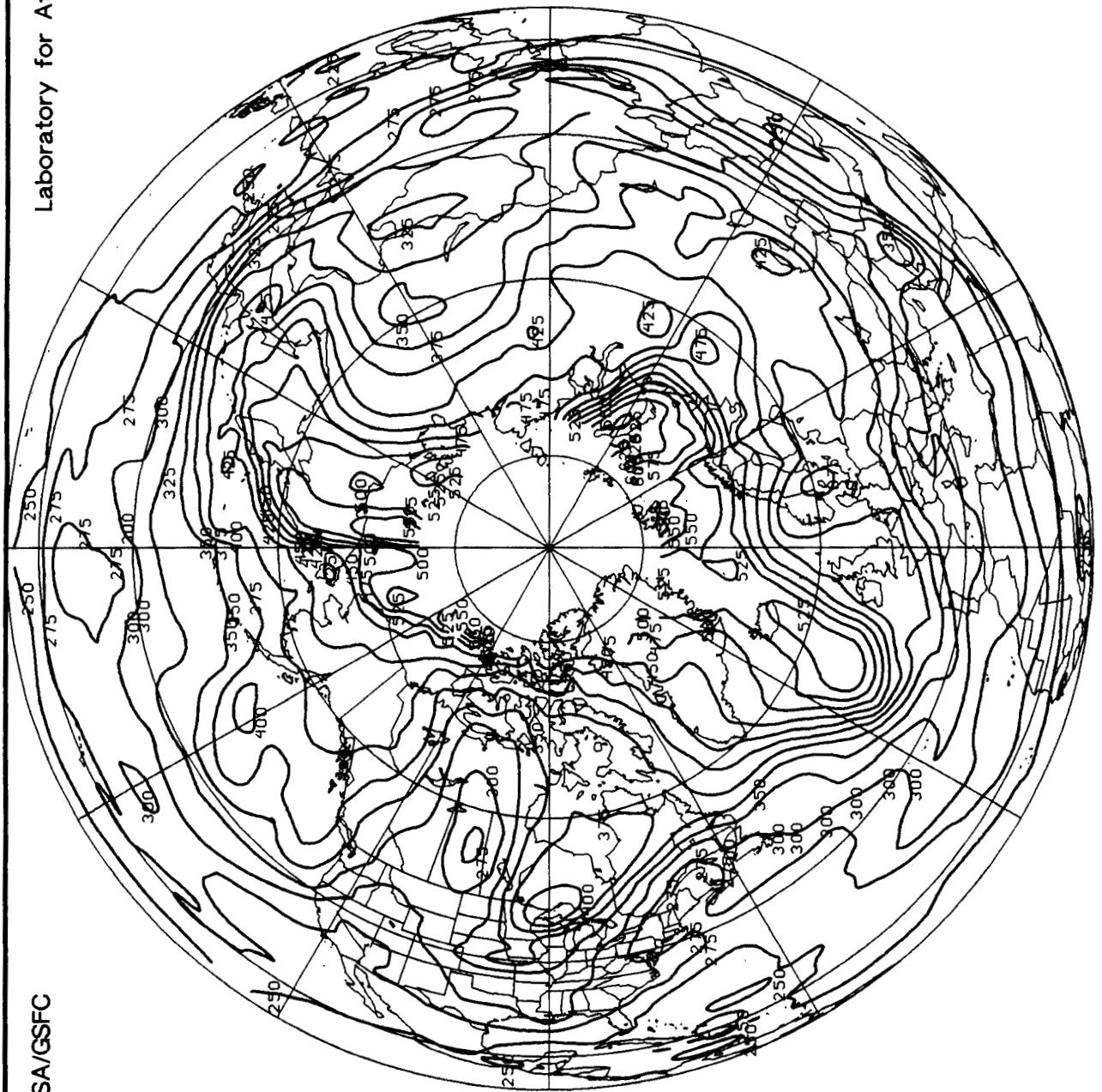


February 21, 1989

Gridded TOMS Ozone (Dobson Units)

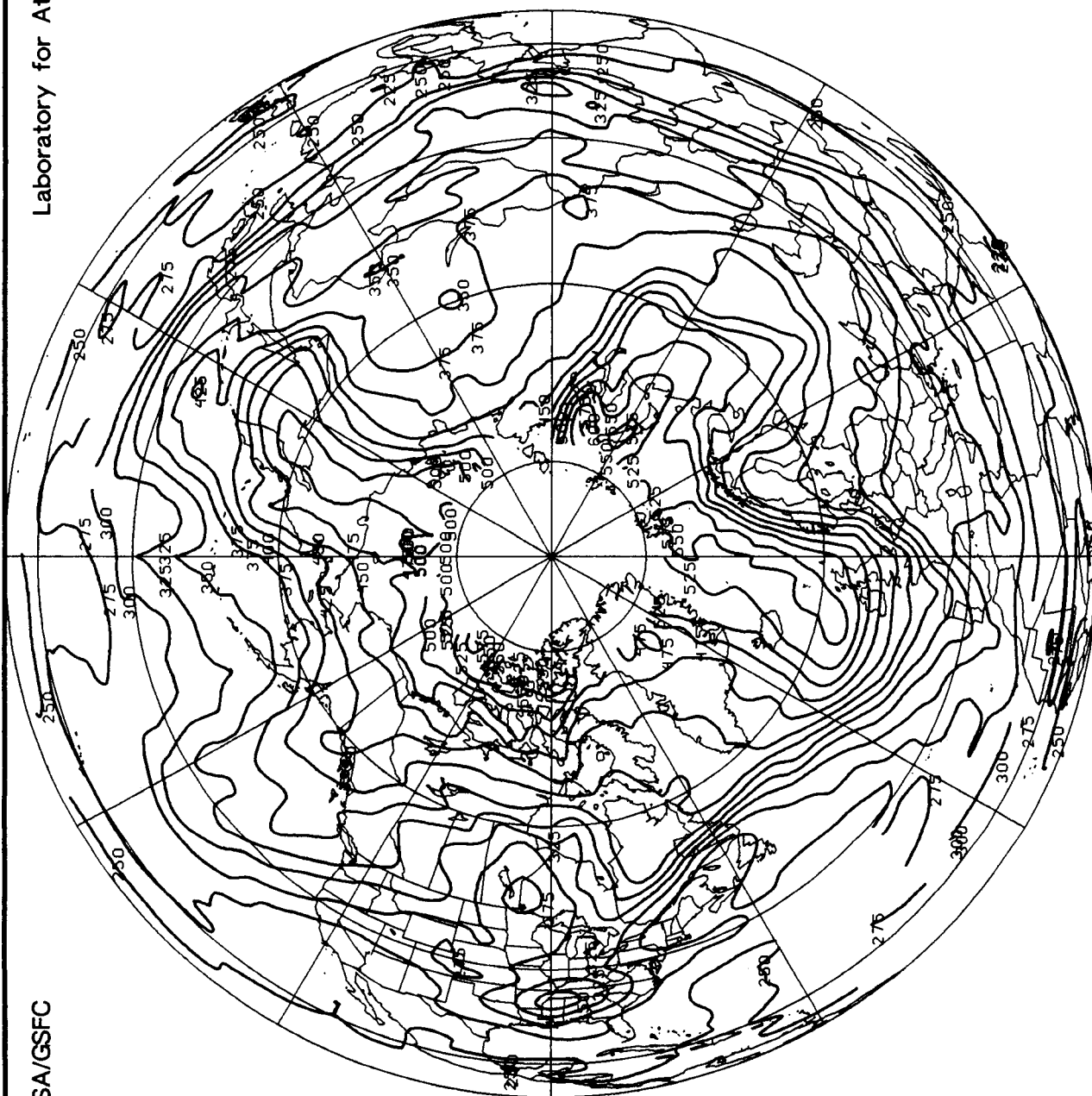
NASA/GSFC

Laboratory for Atmospheres



February 22 1990

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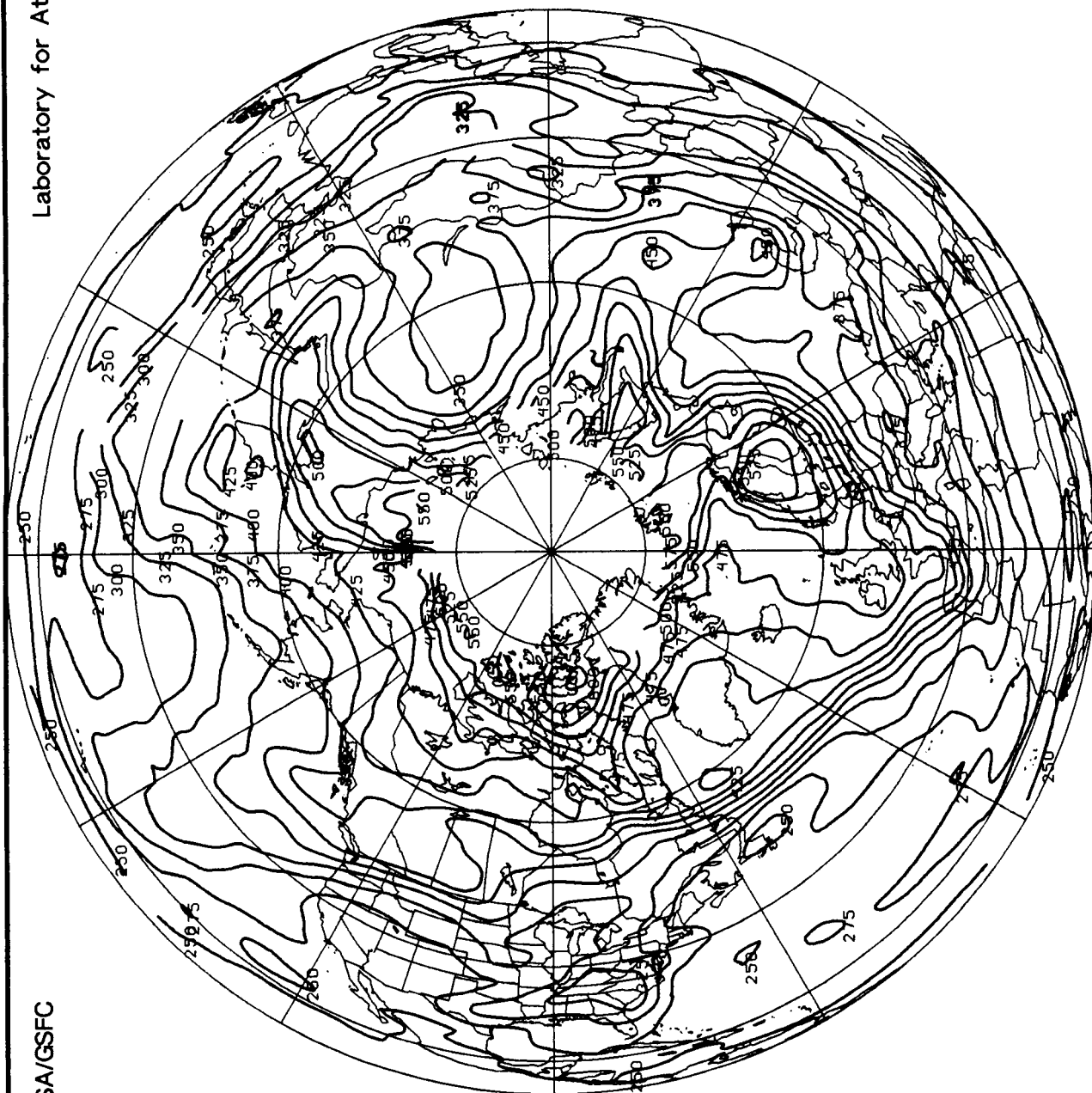


February 23, 1989

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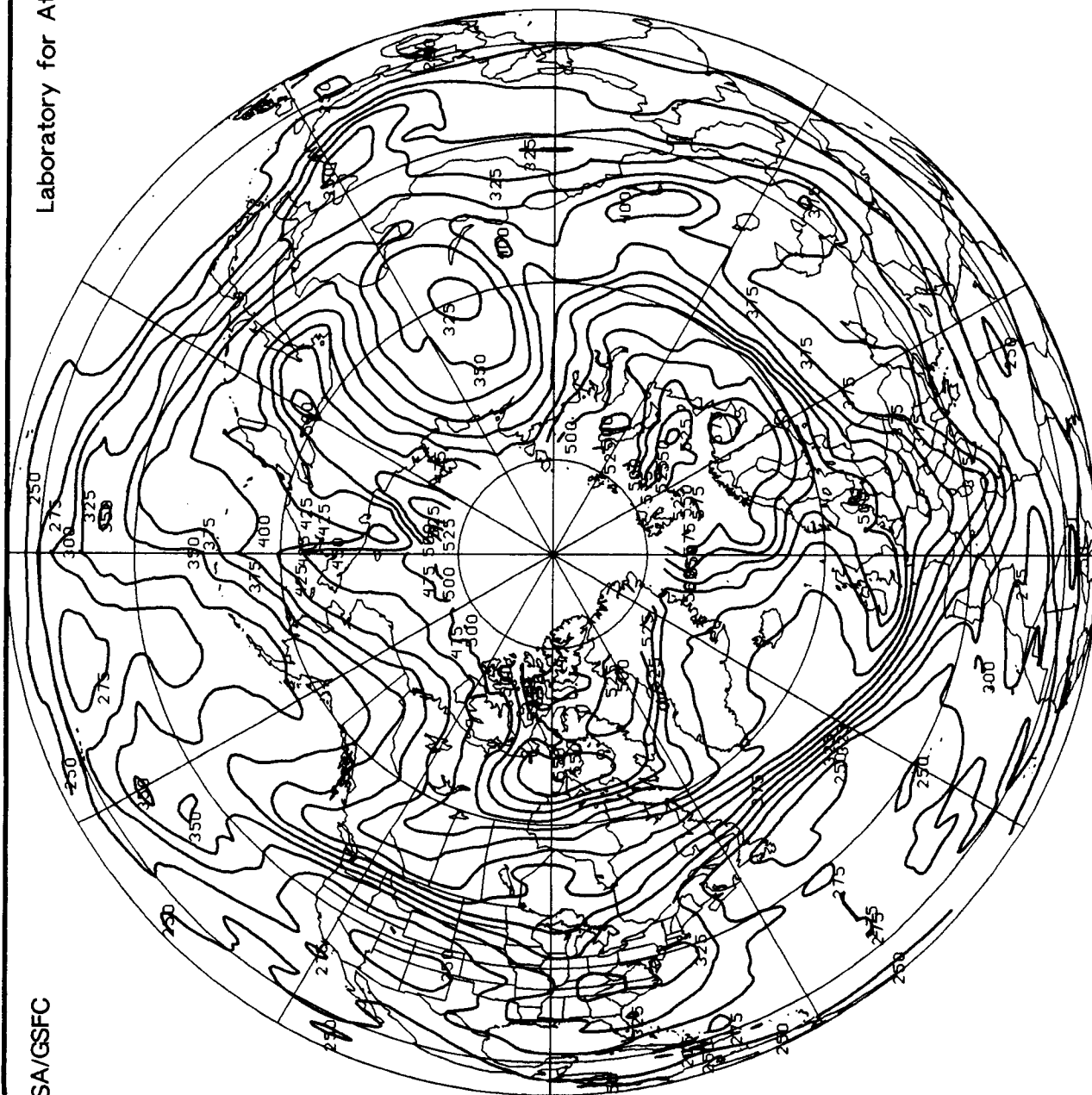
NASA/GSFC

Laboratory for Atmospheres



February 24, 1989

Gridded TOMS Ozone (Dobson Units)

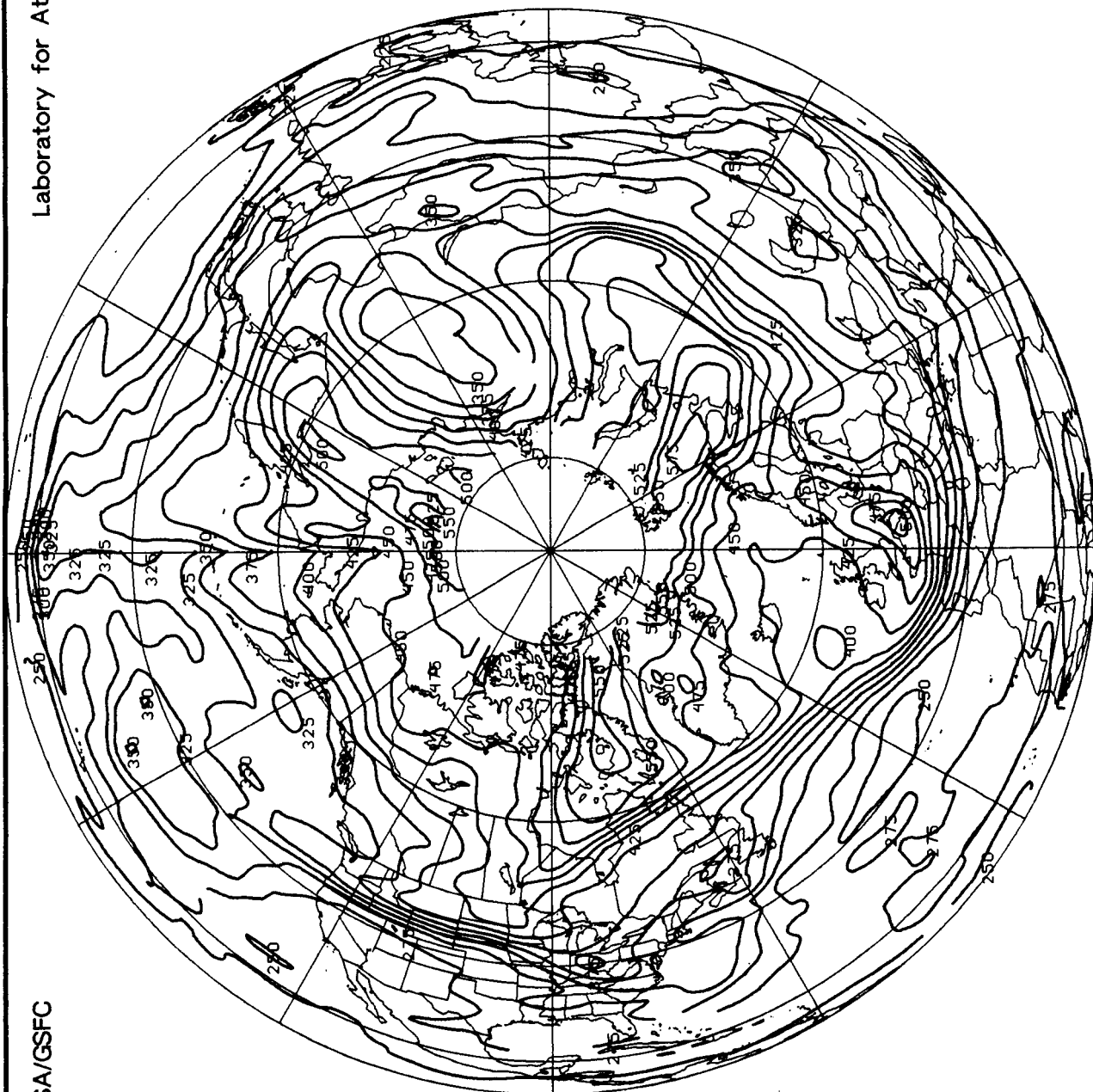


February 25, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

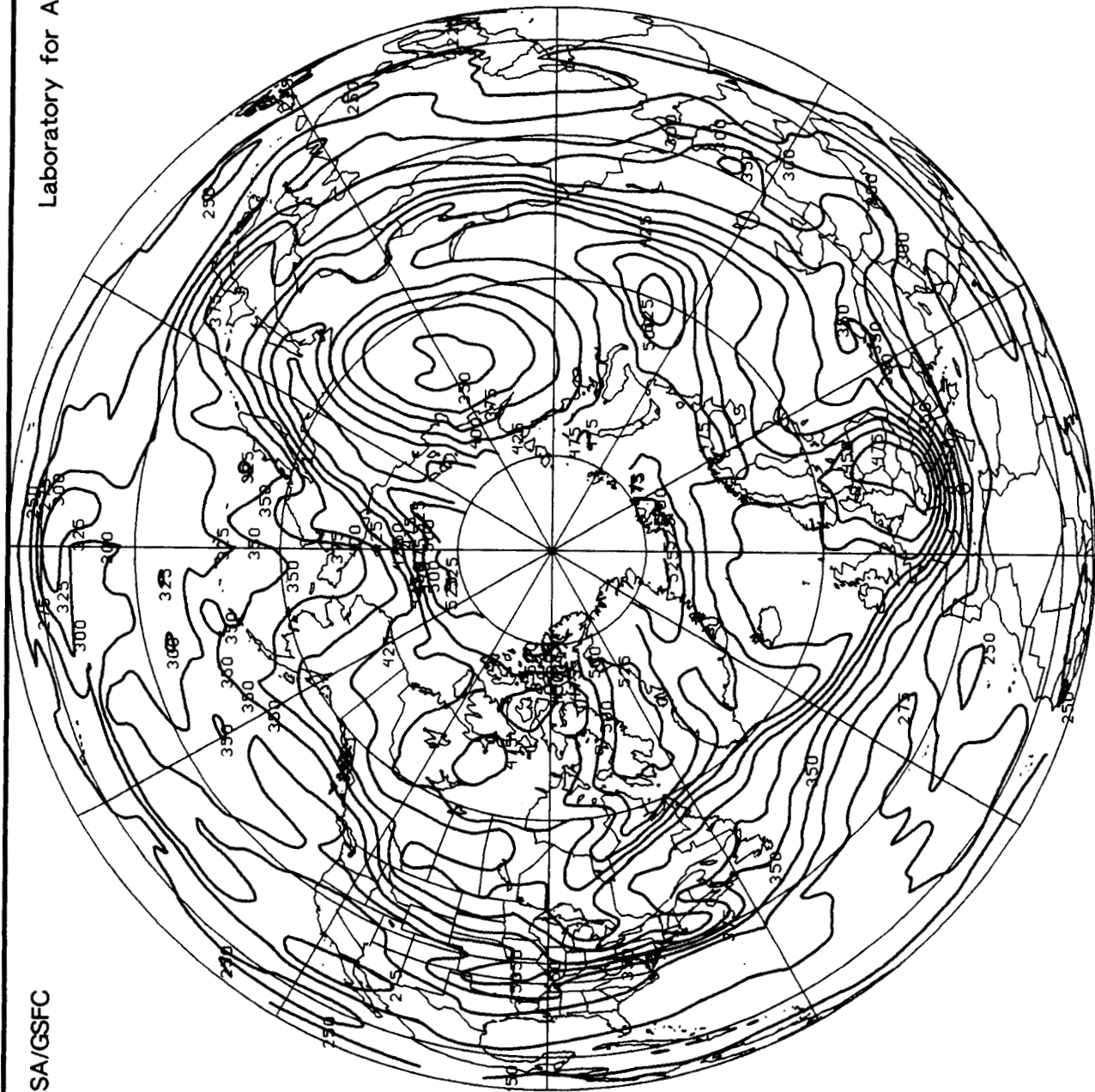


February 26, 1989

Gridded TOMS Ozone (Dobson Units)

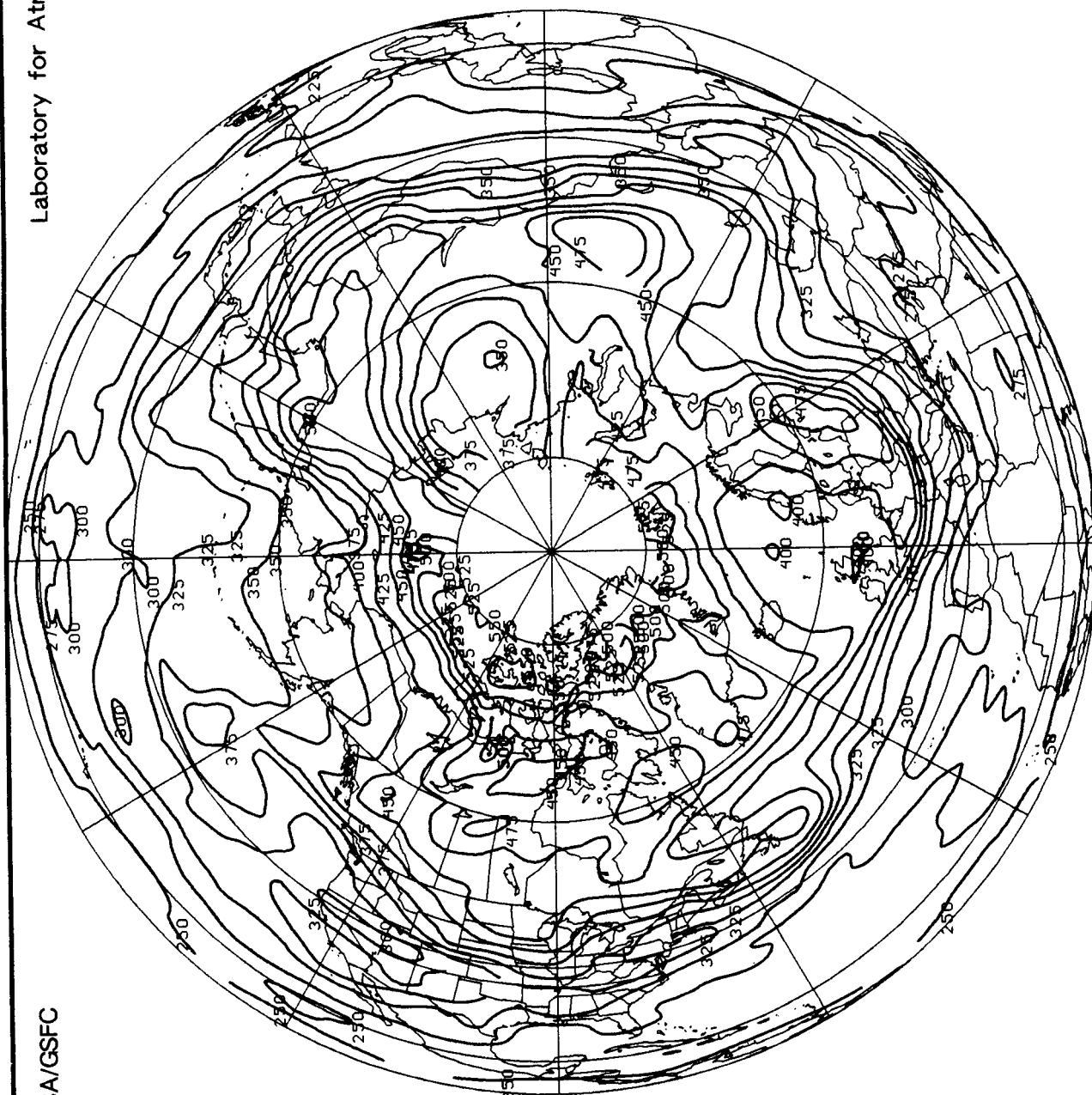
NASA/GSFC

Laboratory for Atmospheres



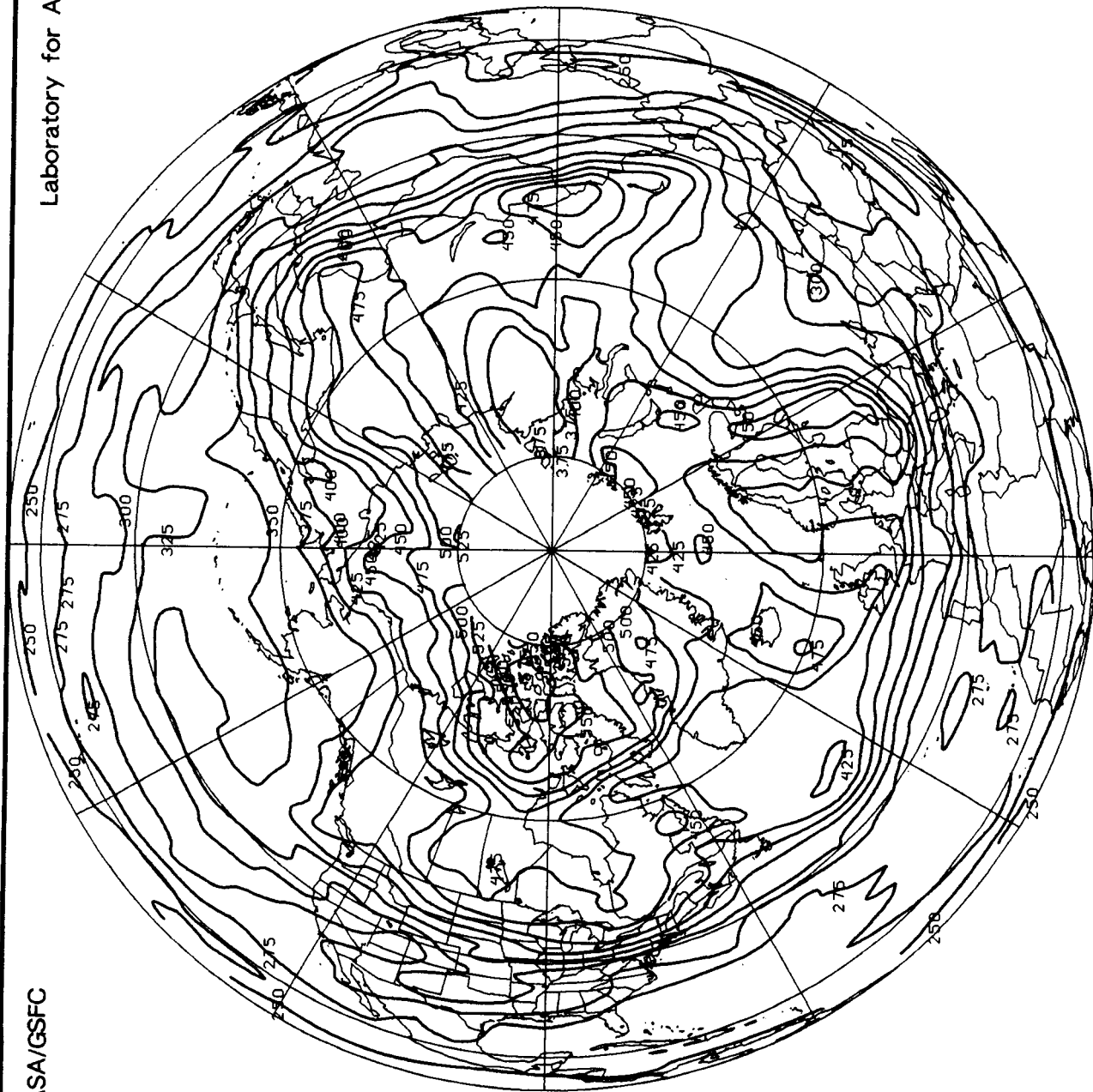
February 27, 1989

Gridded TOMS Ozone (Dobson Units)



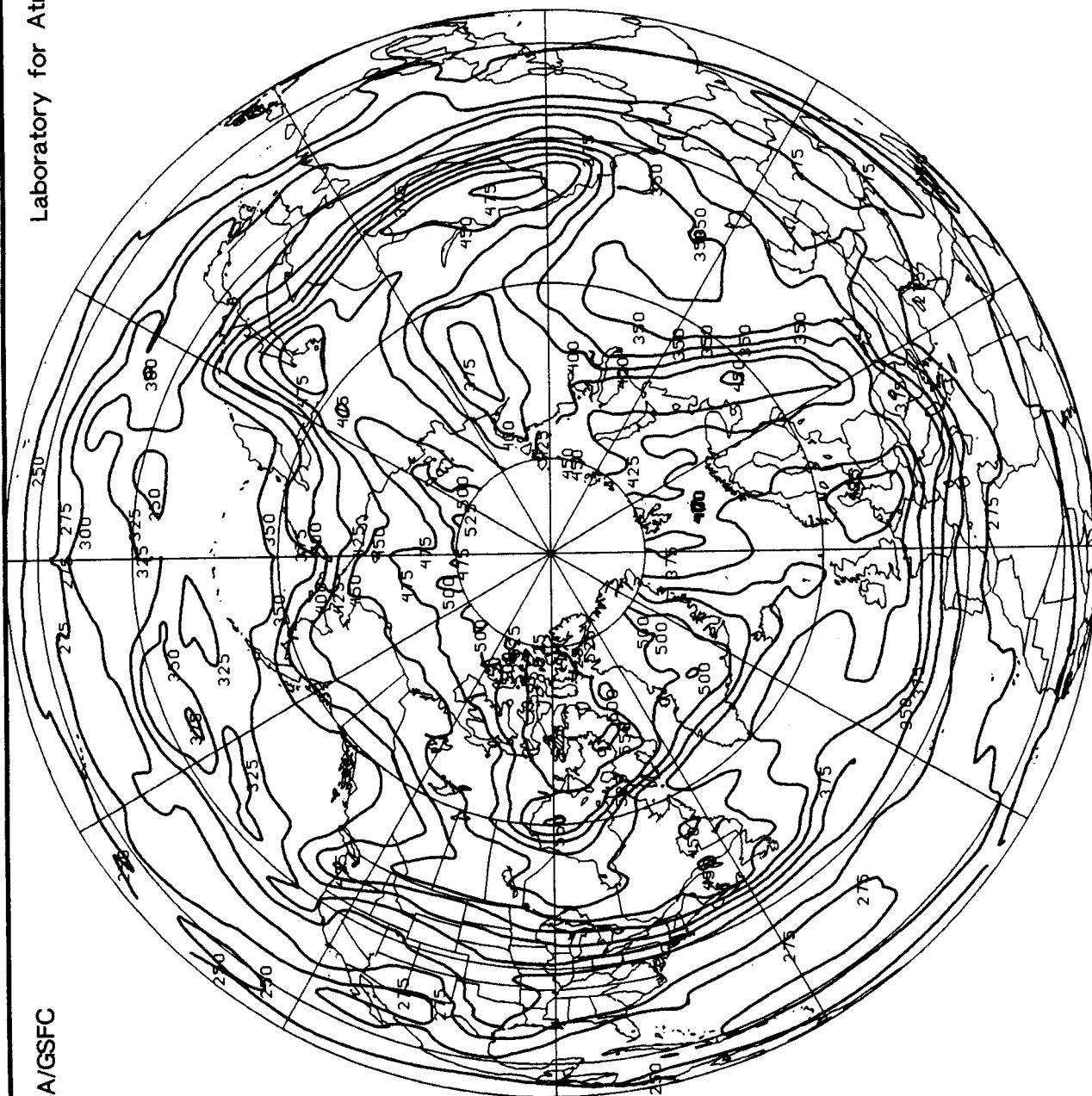
NASA/GSFC

Laboratory for Atmospheres



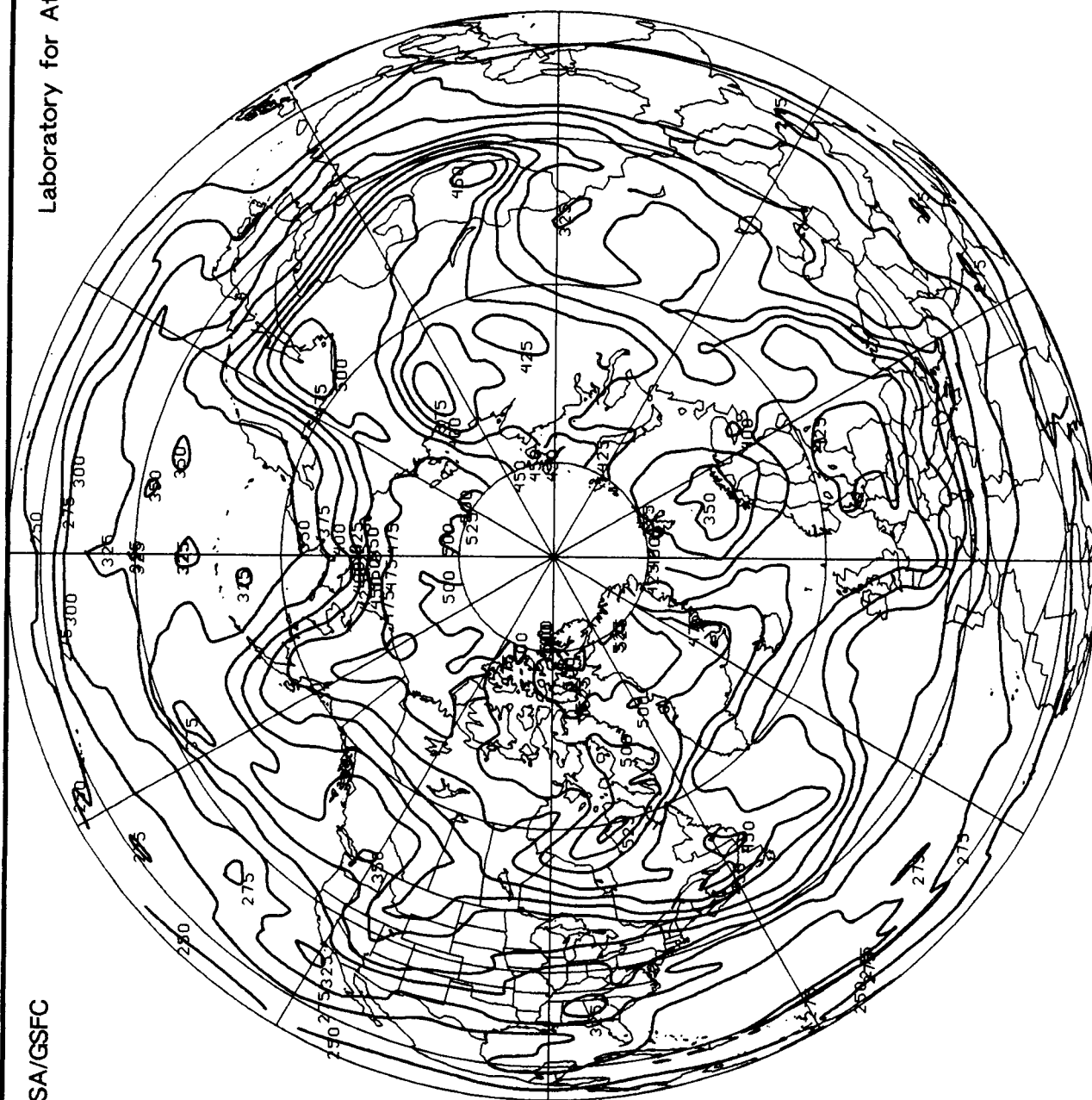
March 1, 1989

Gridded TOMS Ozone (Dobson Units)



March 2, 1989

Gridded TOMS Ozone (Dobson Units)

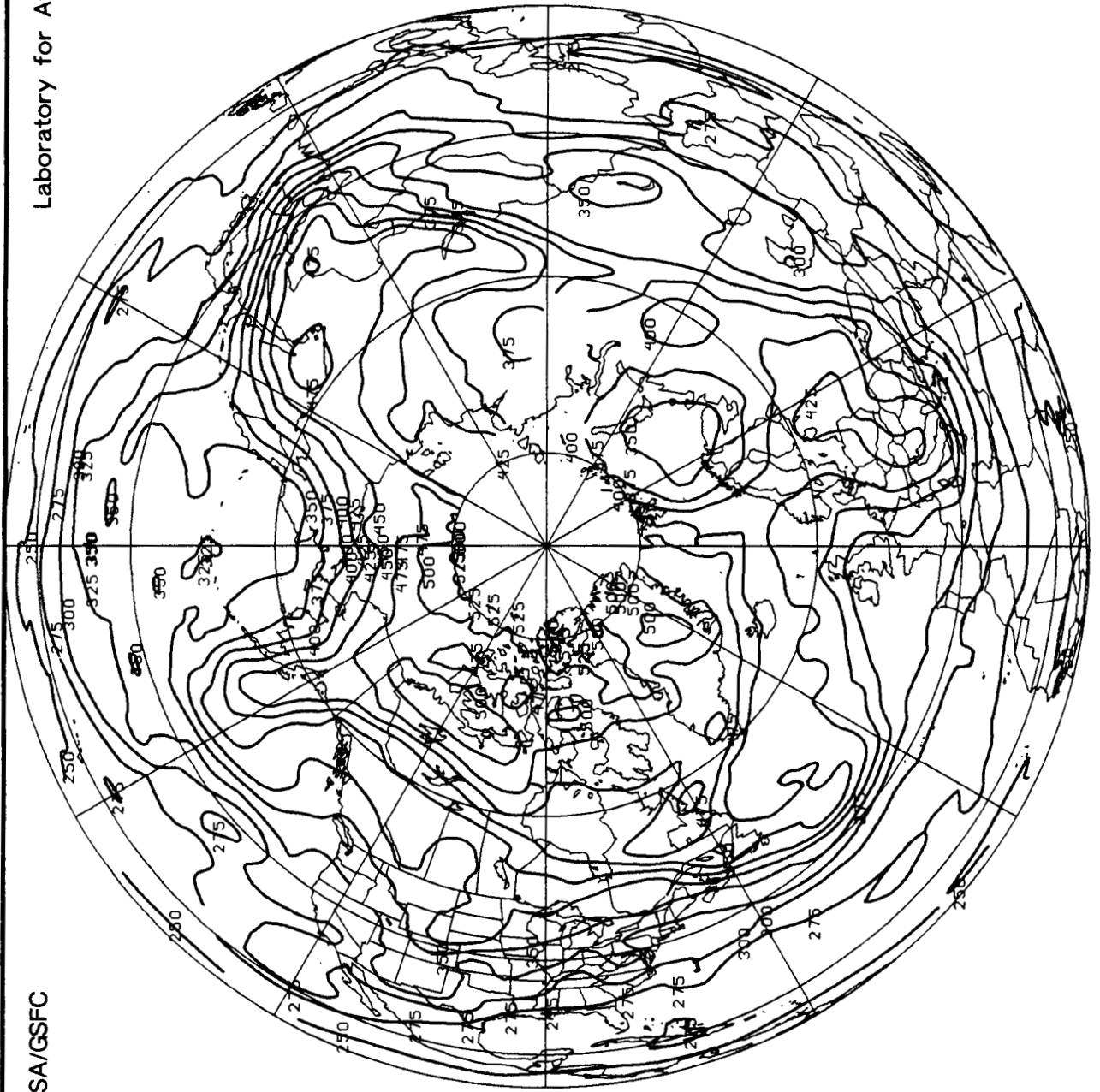


March 3, 1989

Gridded TOMS Ozone (Dobson Units)

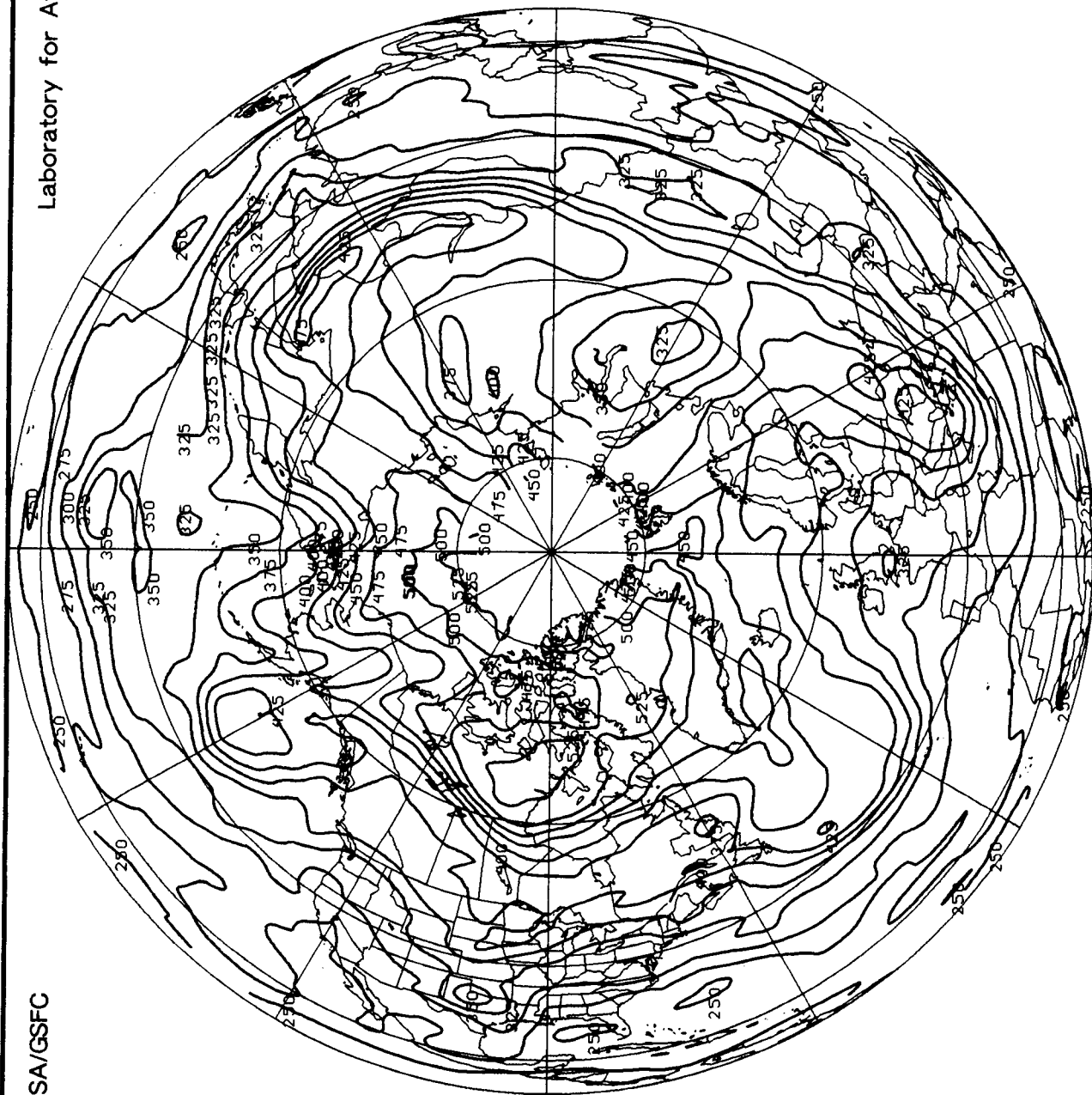
NASA/GSFC

Laboratory for Atmospheres



March 4, 1989

Gridded TOMS Ozone (Dobson Units)

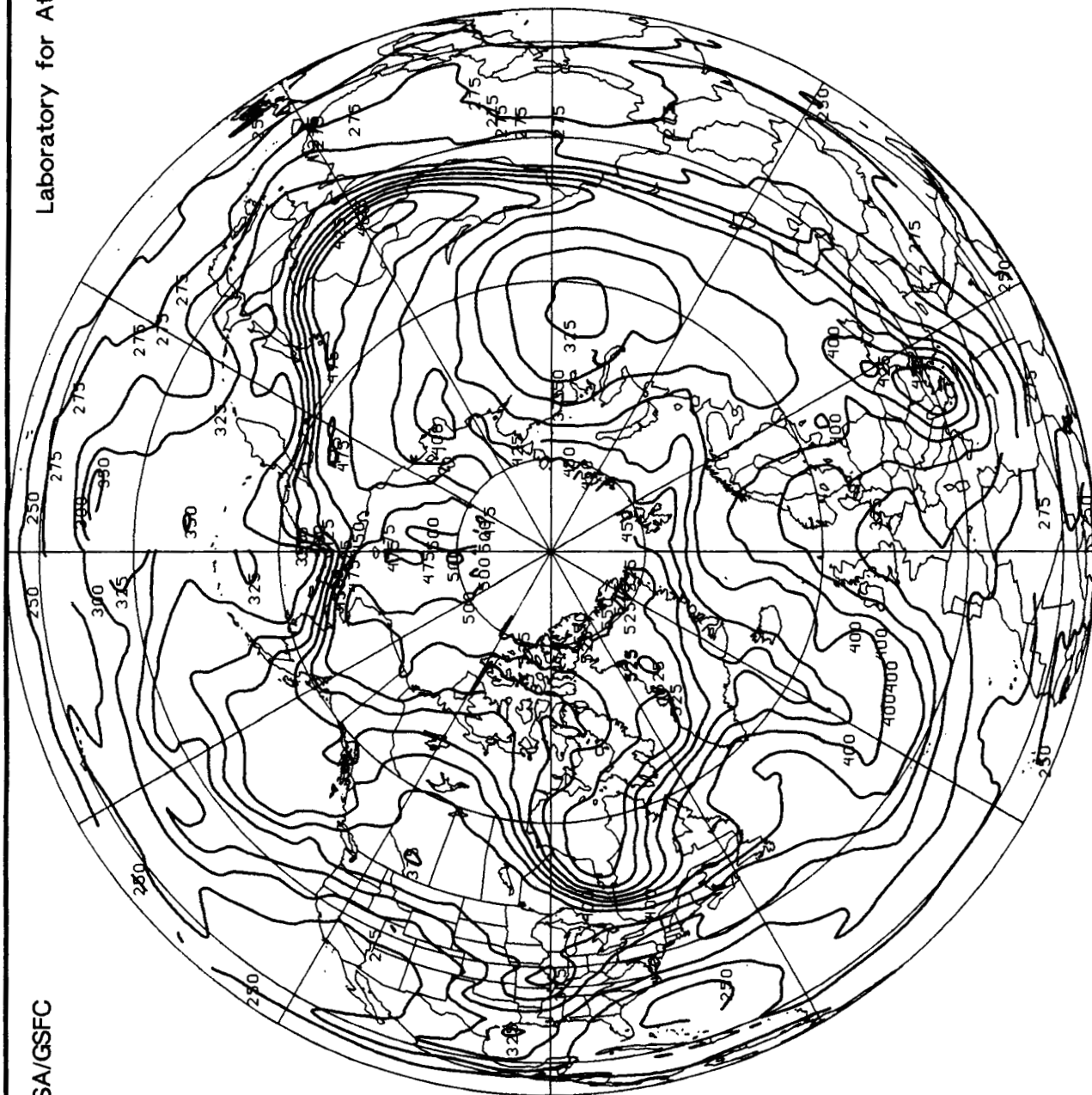


March 5, 1989

Gridded TOMS Ozone (Dobson Units)

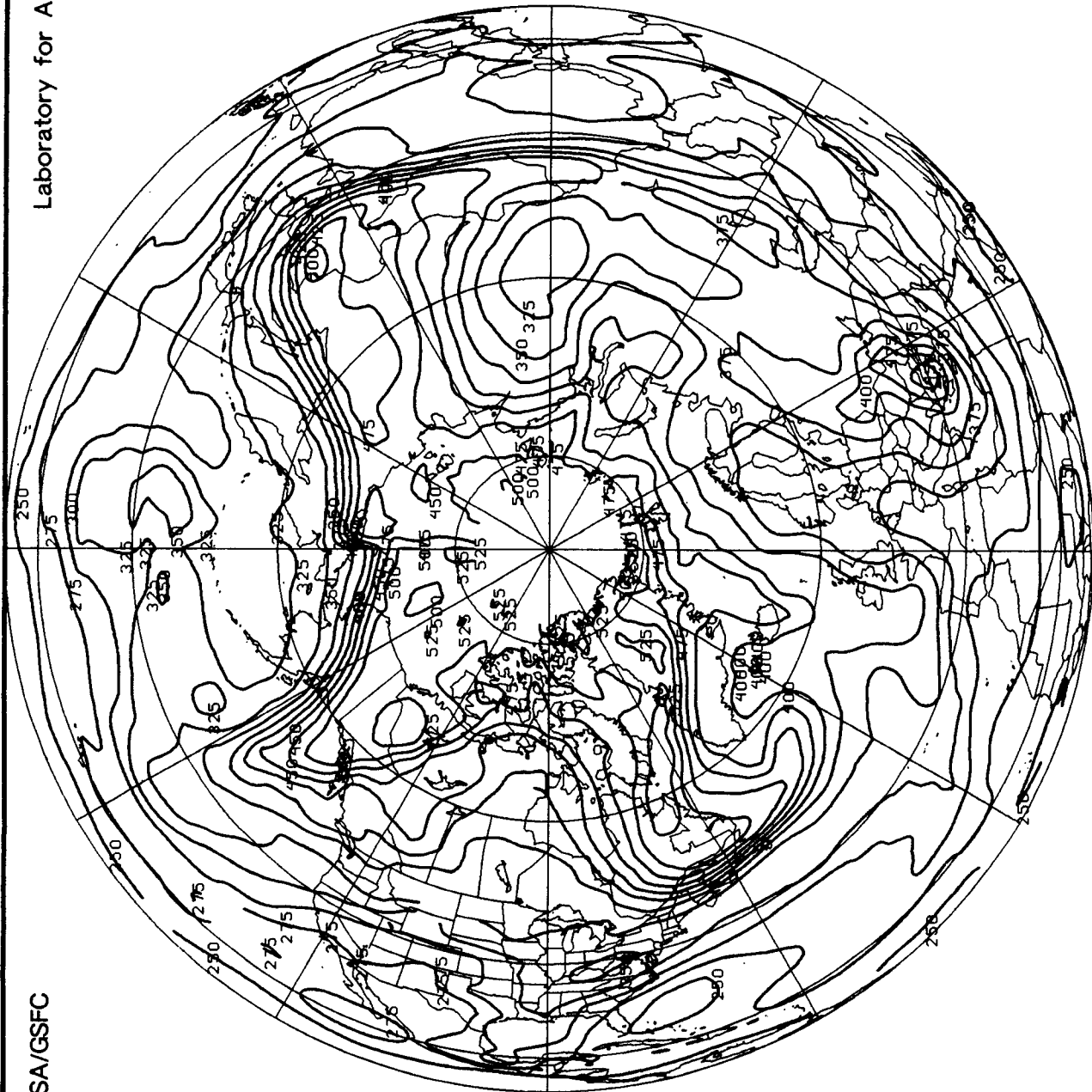
NASA/GSFC

Laboratory for Atmospheres



March 6, 1989

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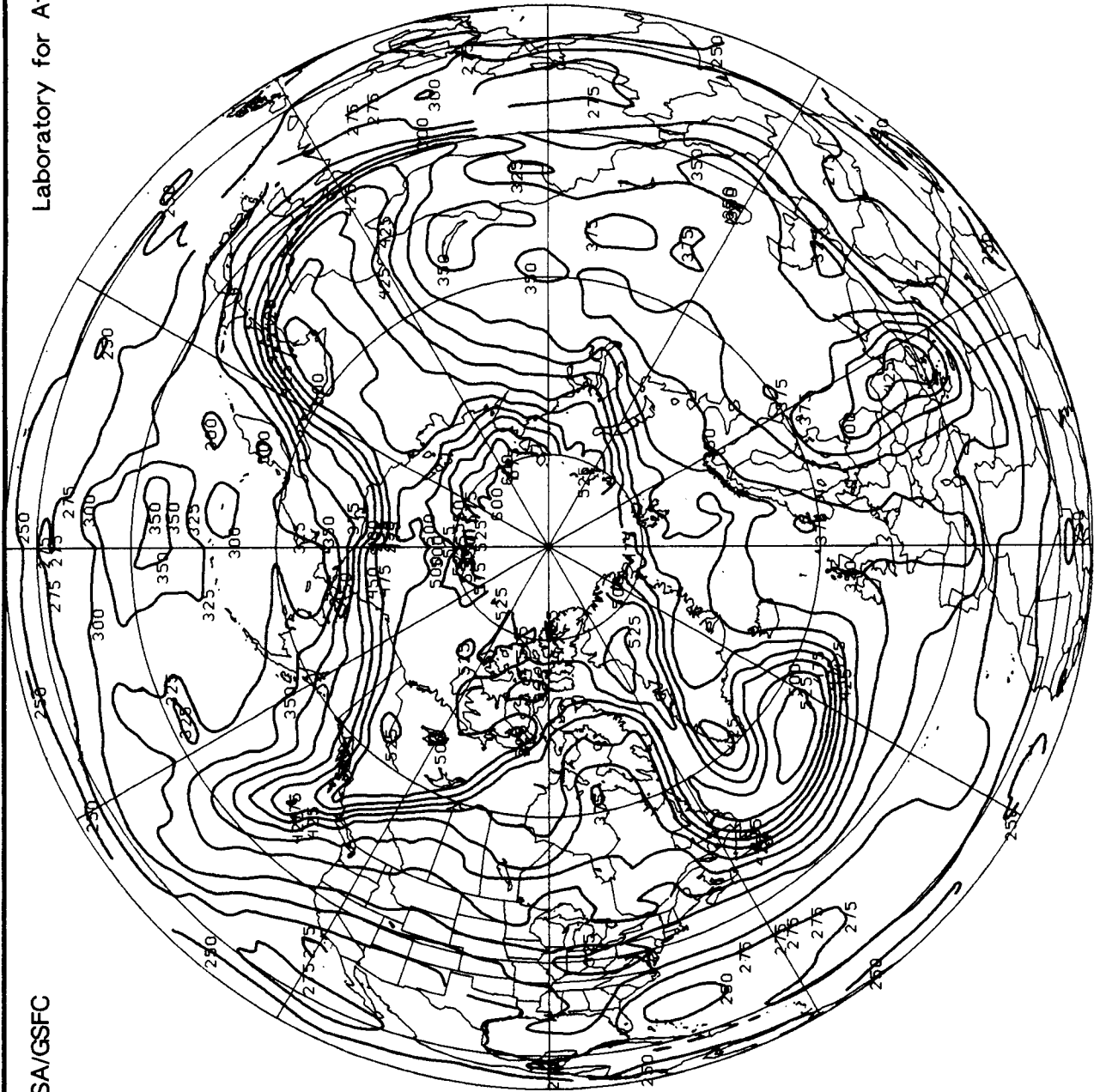


March 7, 1989

Gridded TOMS Ozone (Dobson Units)

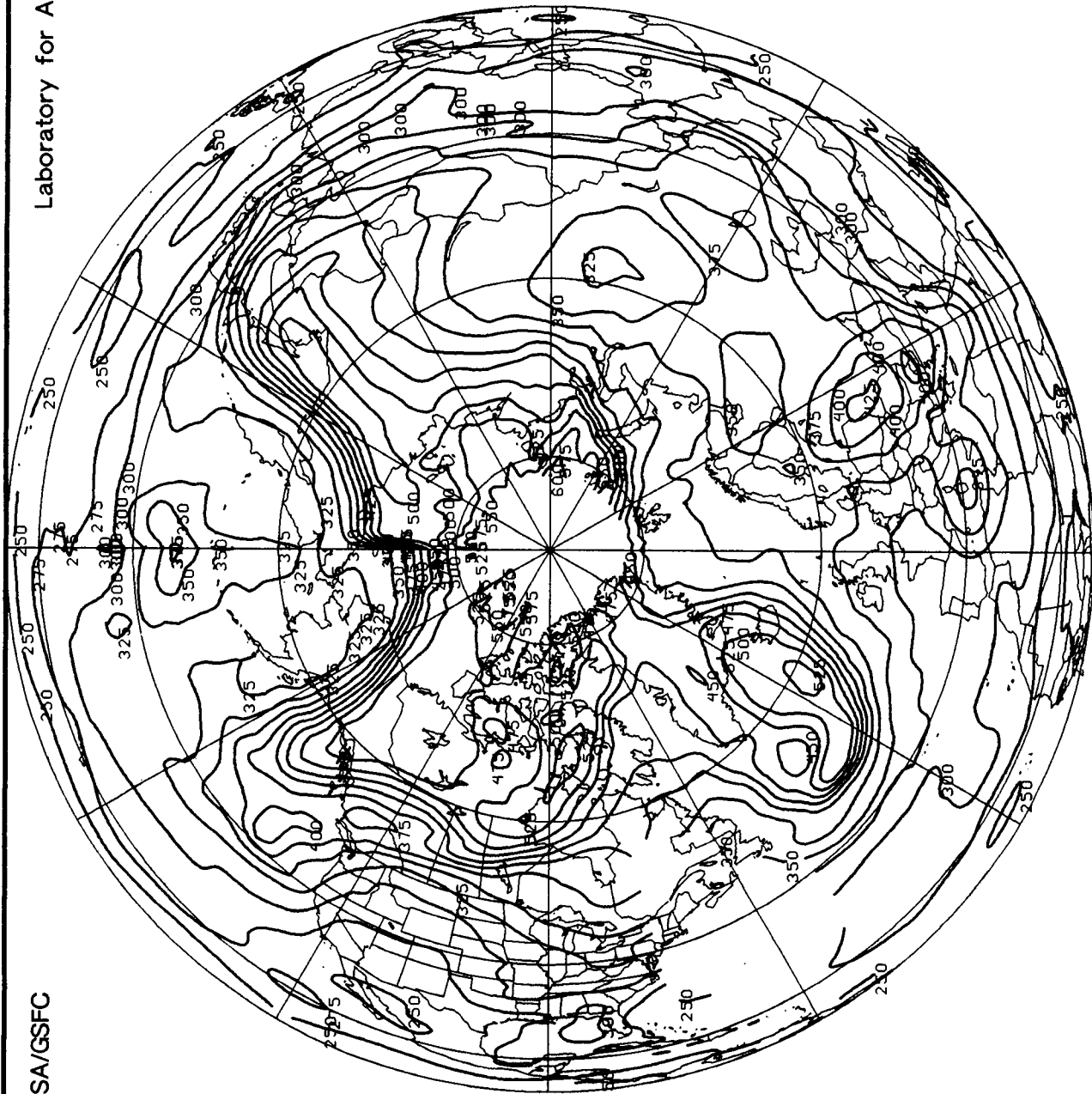
NASA/GSFC

Laboratory for Atmospheres



March 8, 1989

Gridded TOMS Ozone (Dobson Units)

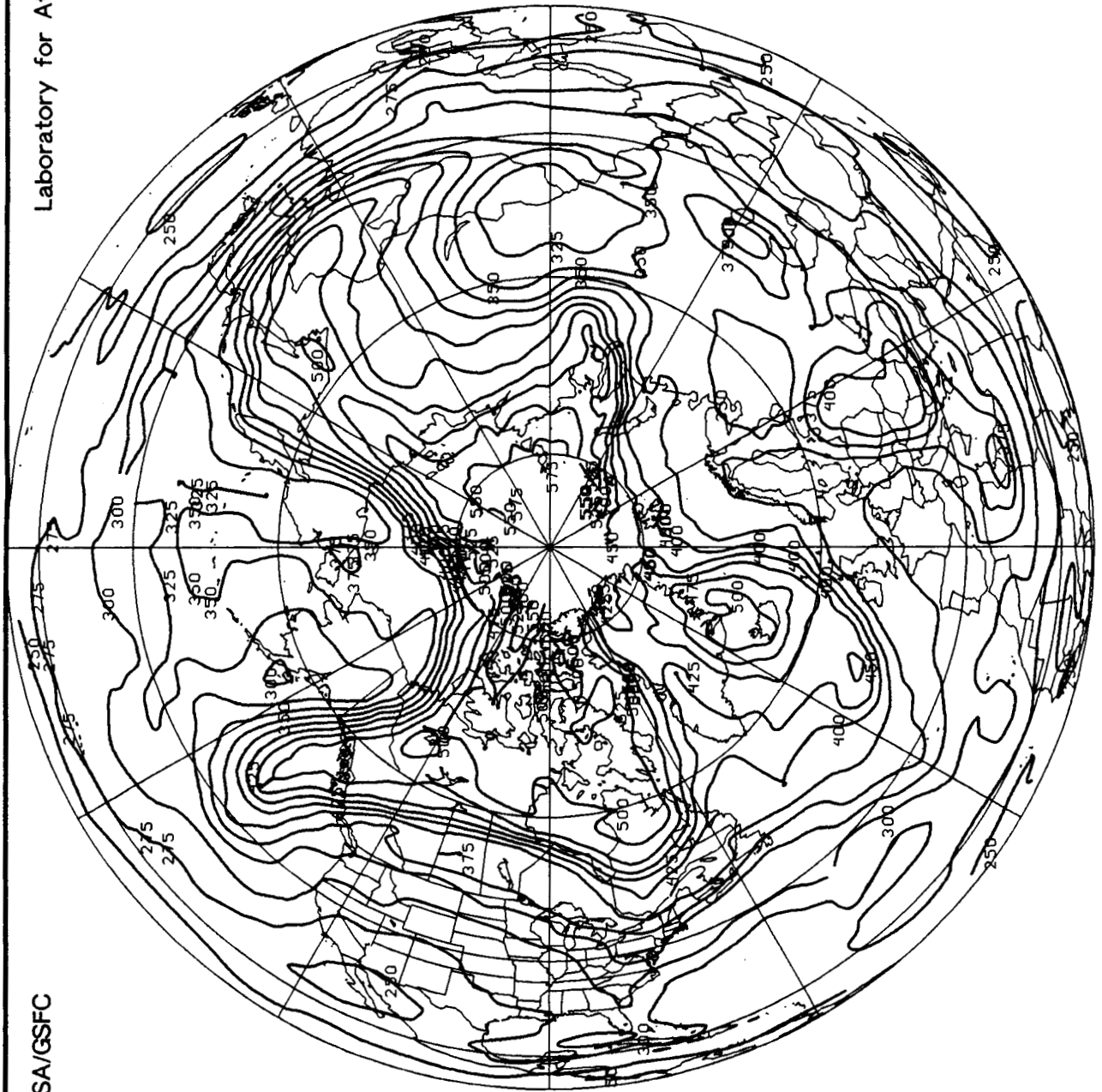


March 9, 1989

Gridded TOMS Ozone (Dobson Units)

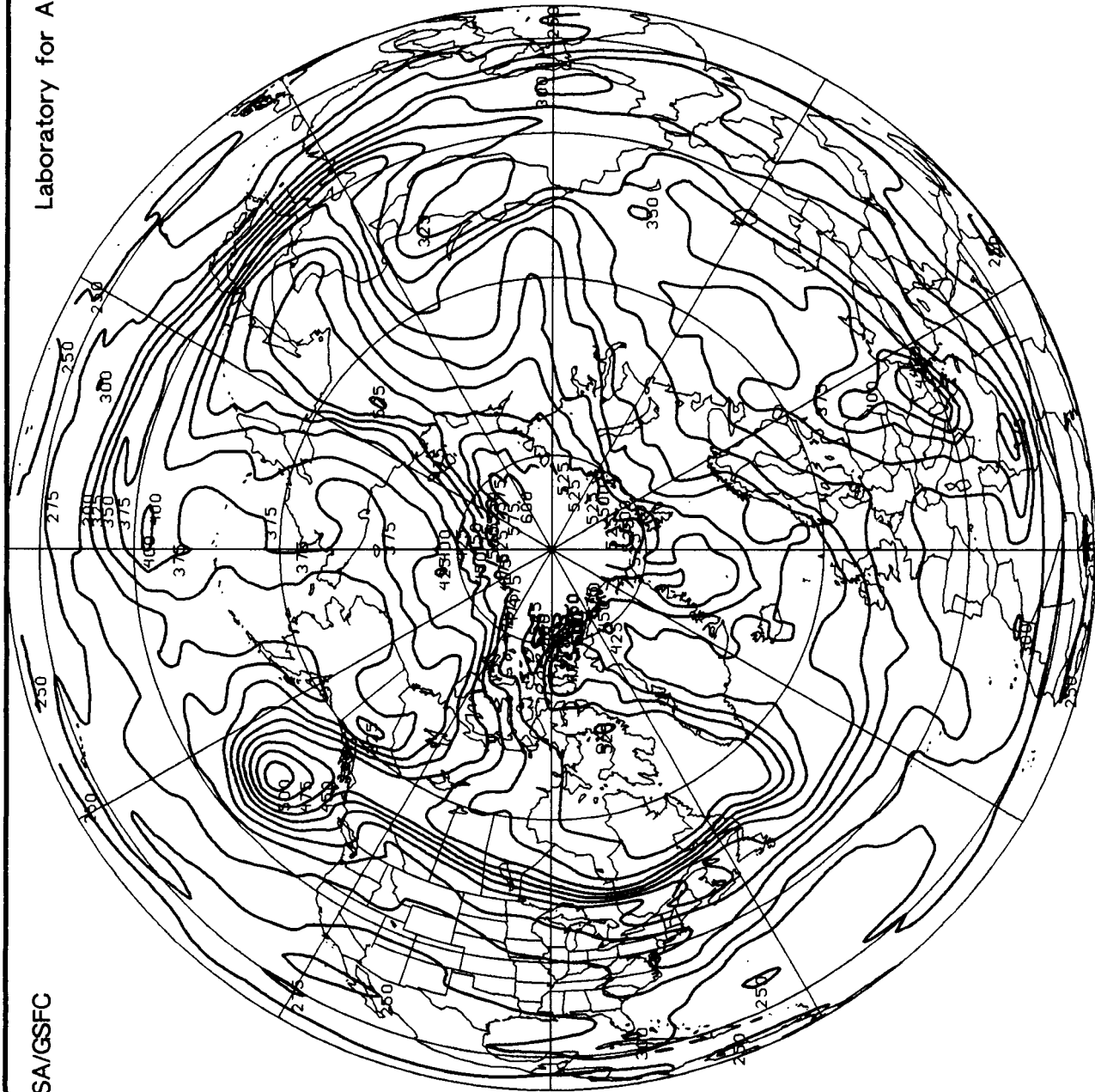
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March 10, 1989

Gridded TOMS Ozone (Dobson Units)

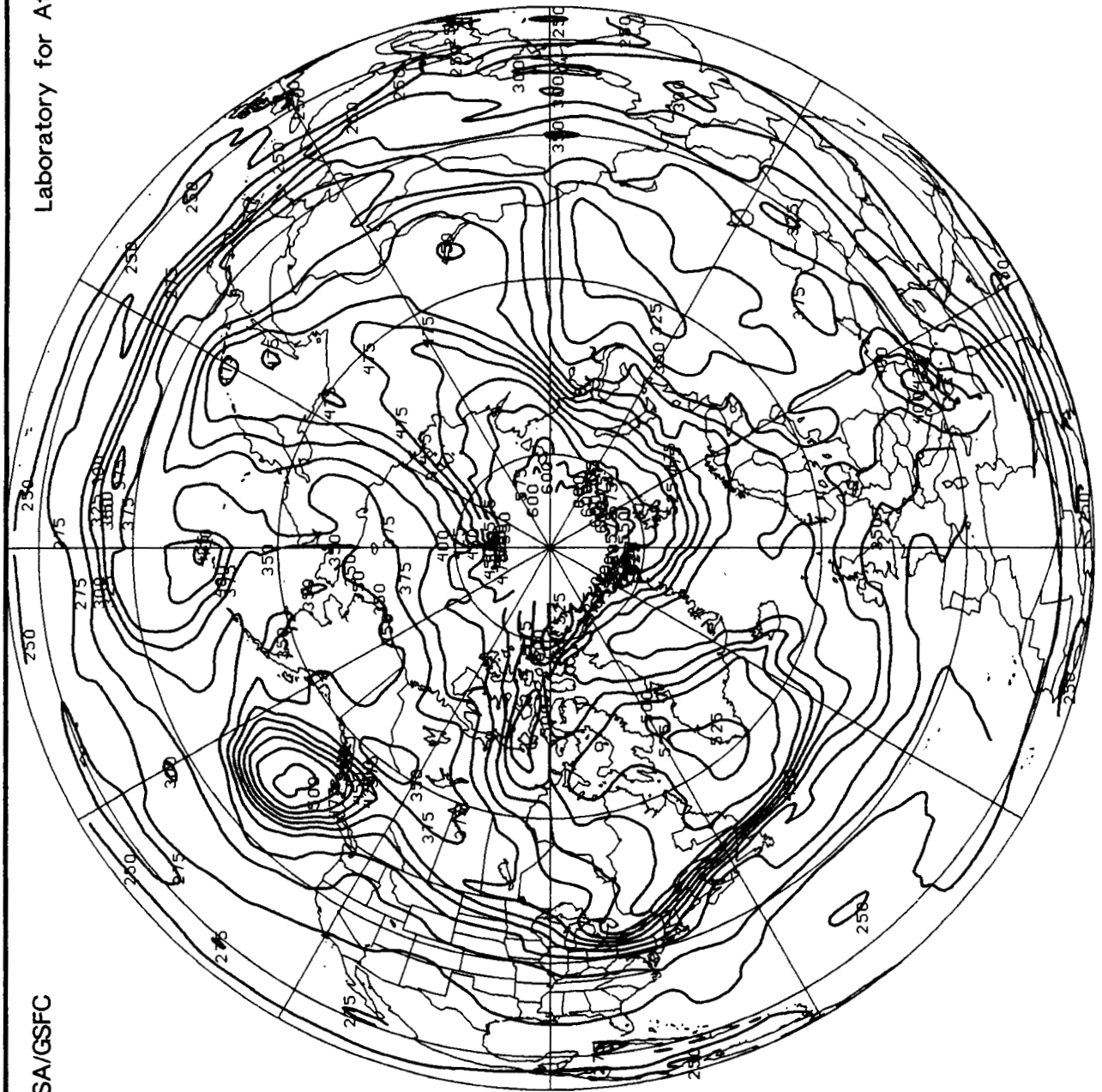


March 11, 1989

Gridded TOMS Ozone (Dobson Units)

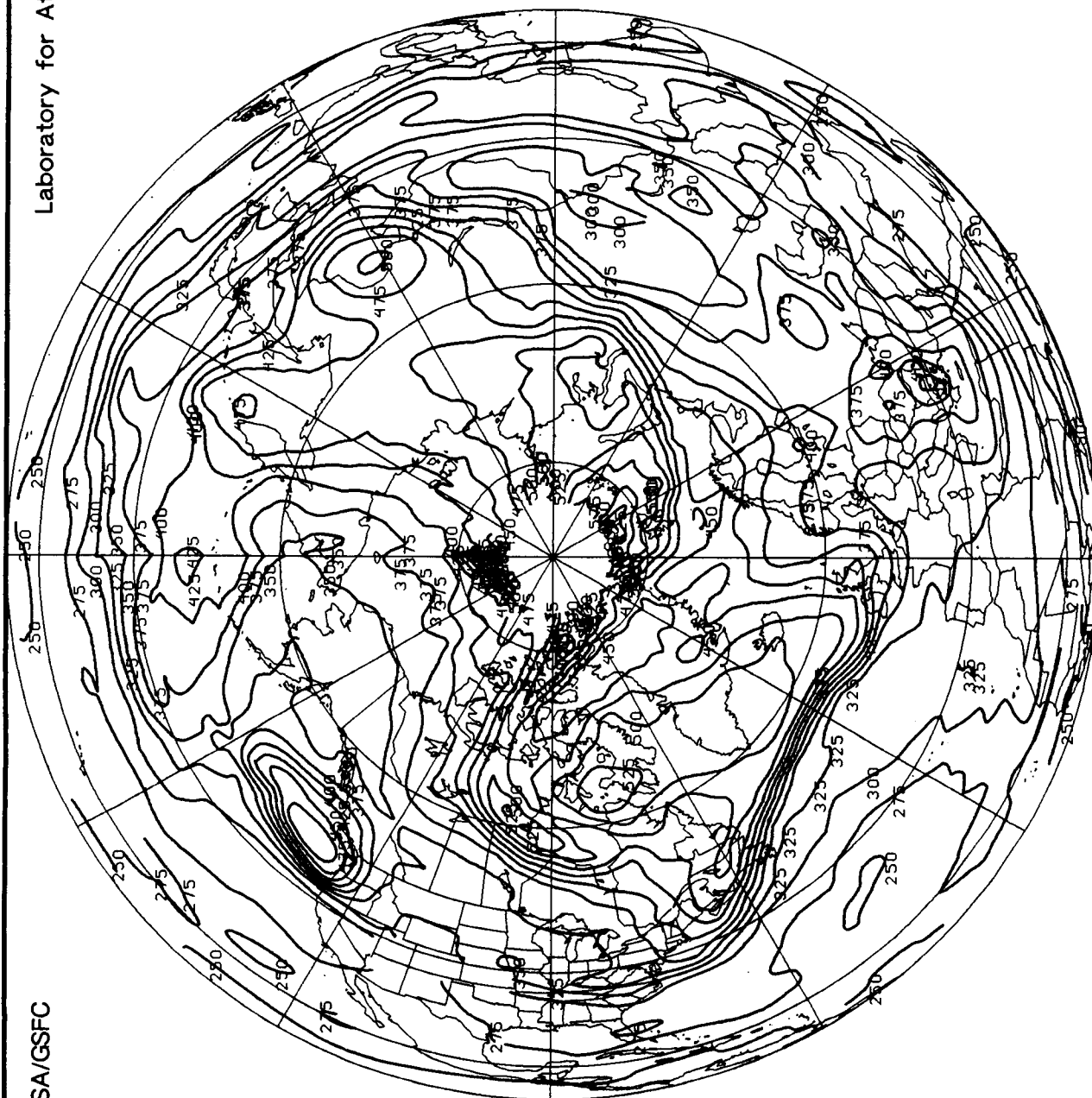
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March 12 1989

Gridded TOMS Ozone (Dobson Units)

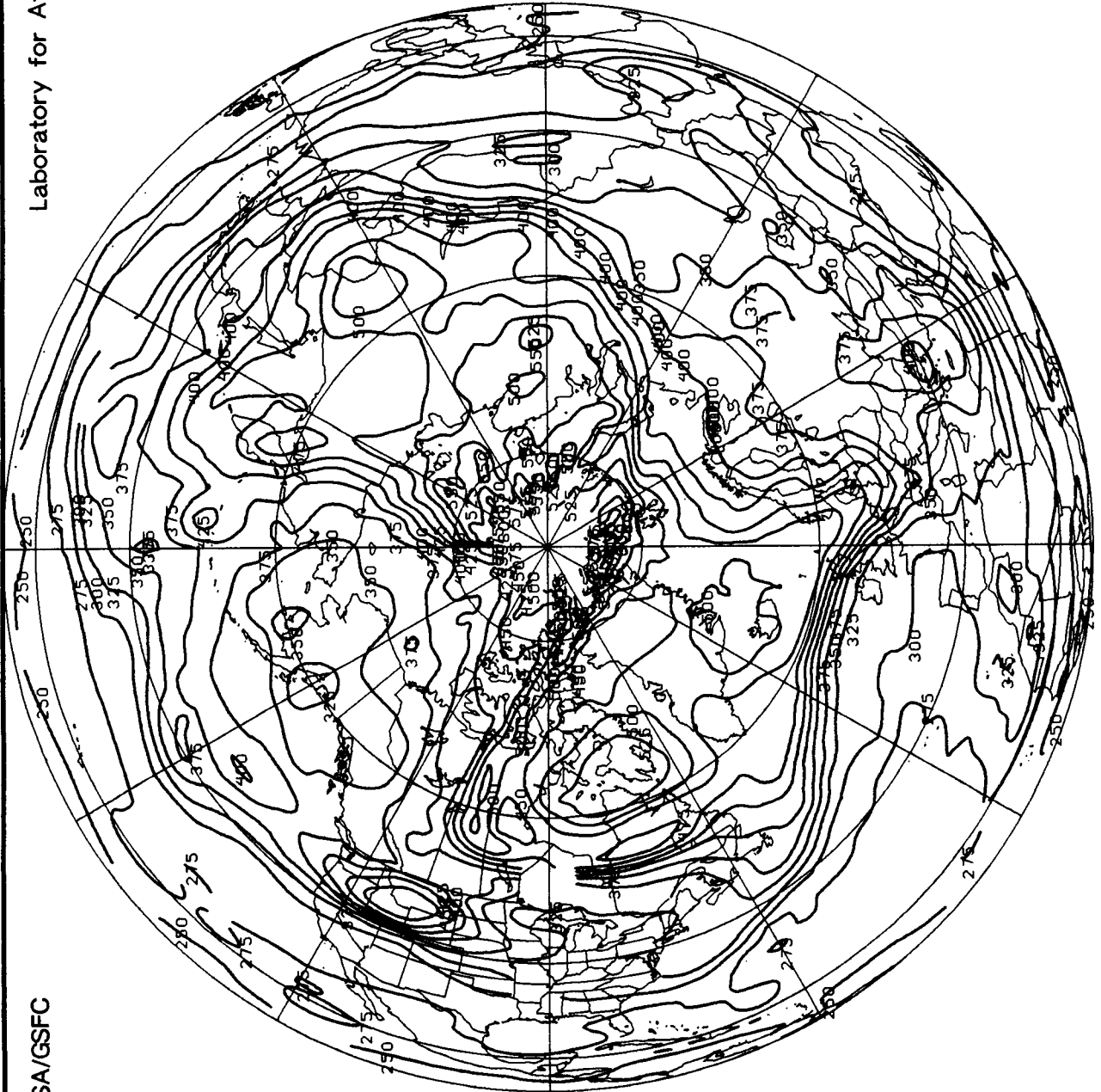


March 13, 1989

Gridded TOMS Ozone (Dobson Units)

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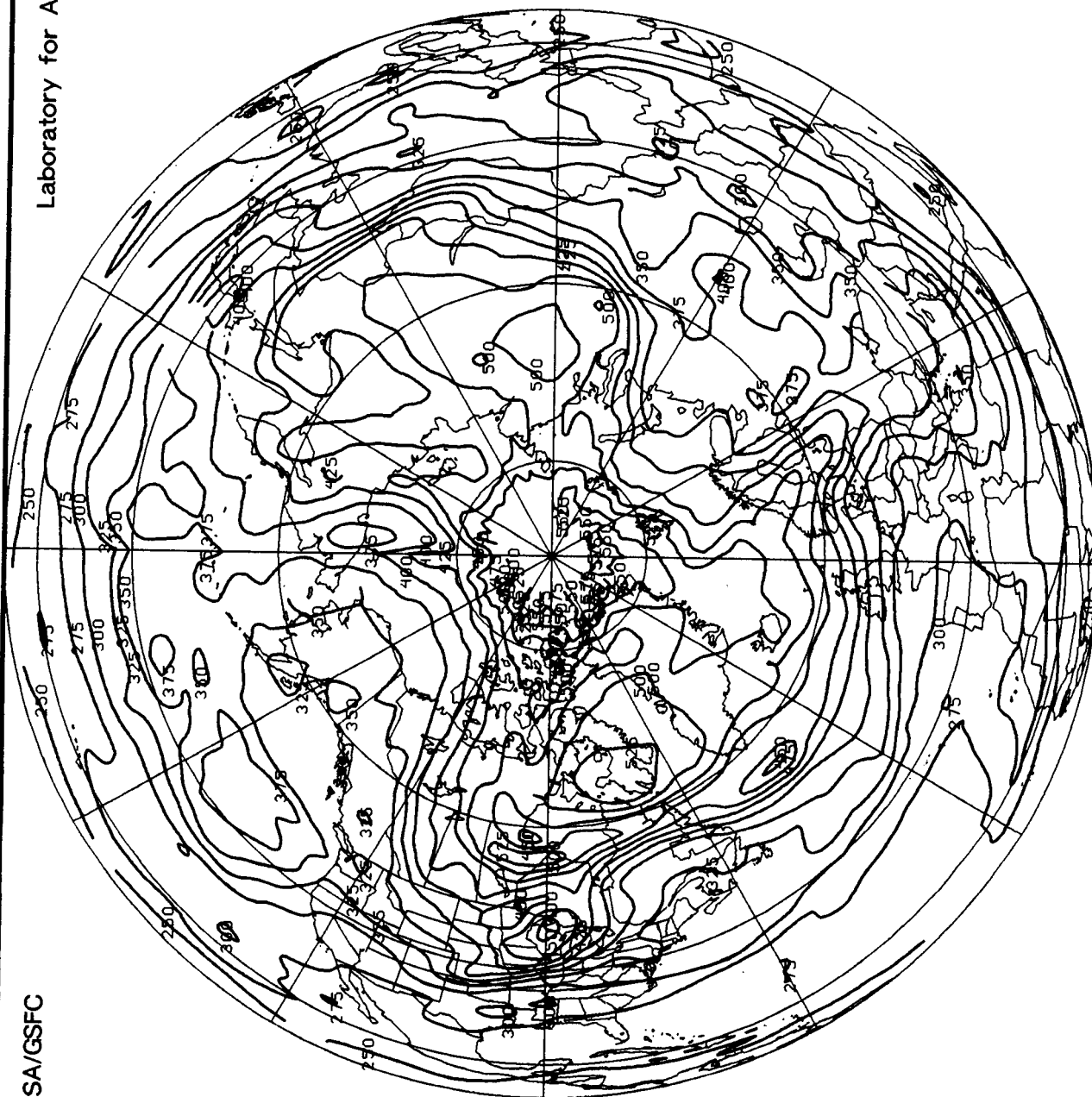


March 14, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

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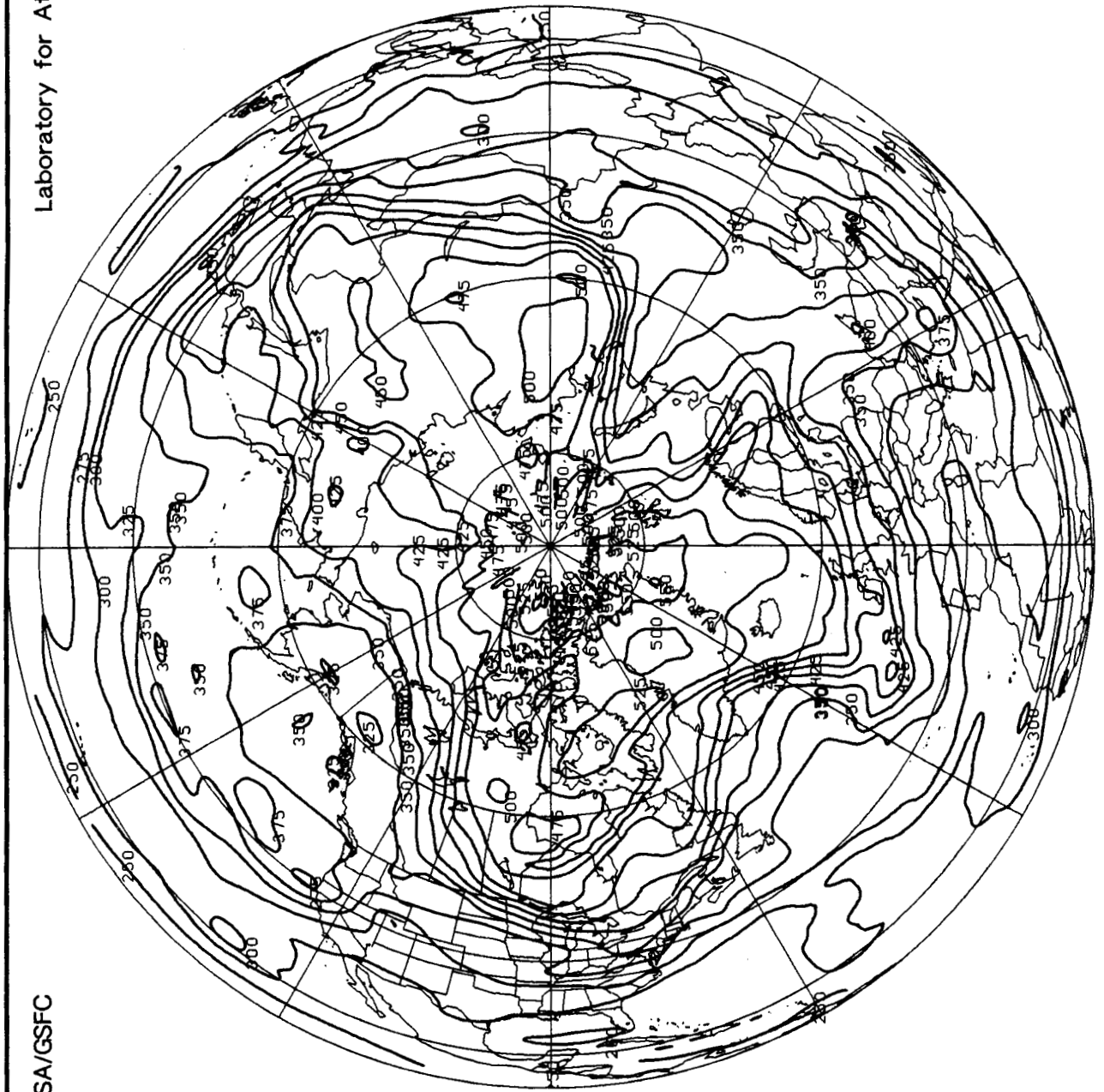


March 15, 1989

Gridded TOMS Ozone (Dobson Units)

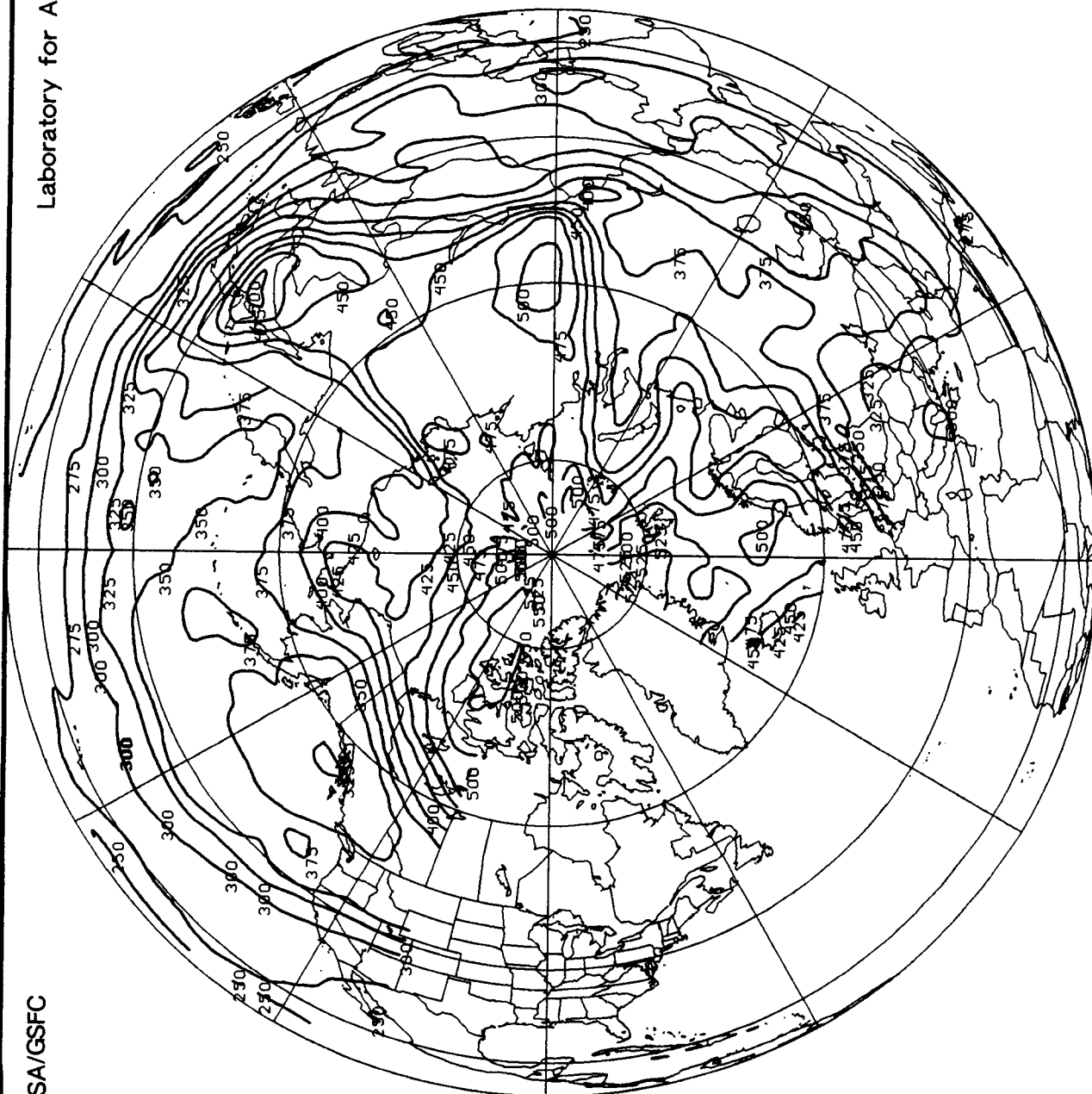
NASA/GSFC

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March 16, 1989

Gridded TOMS Ozone (Dobson Units)

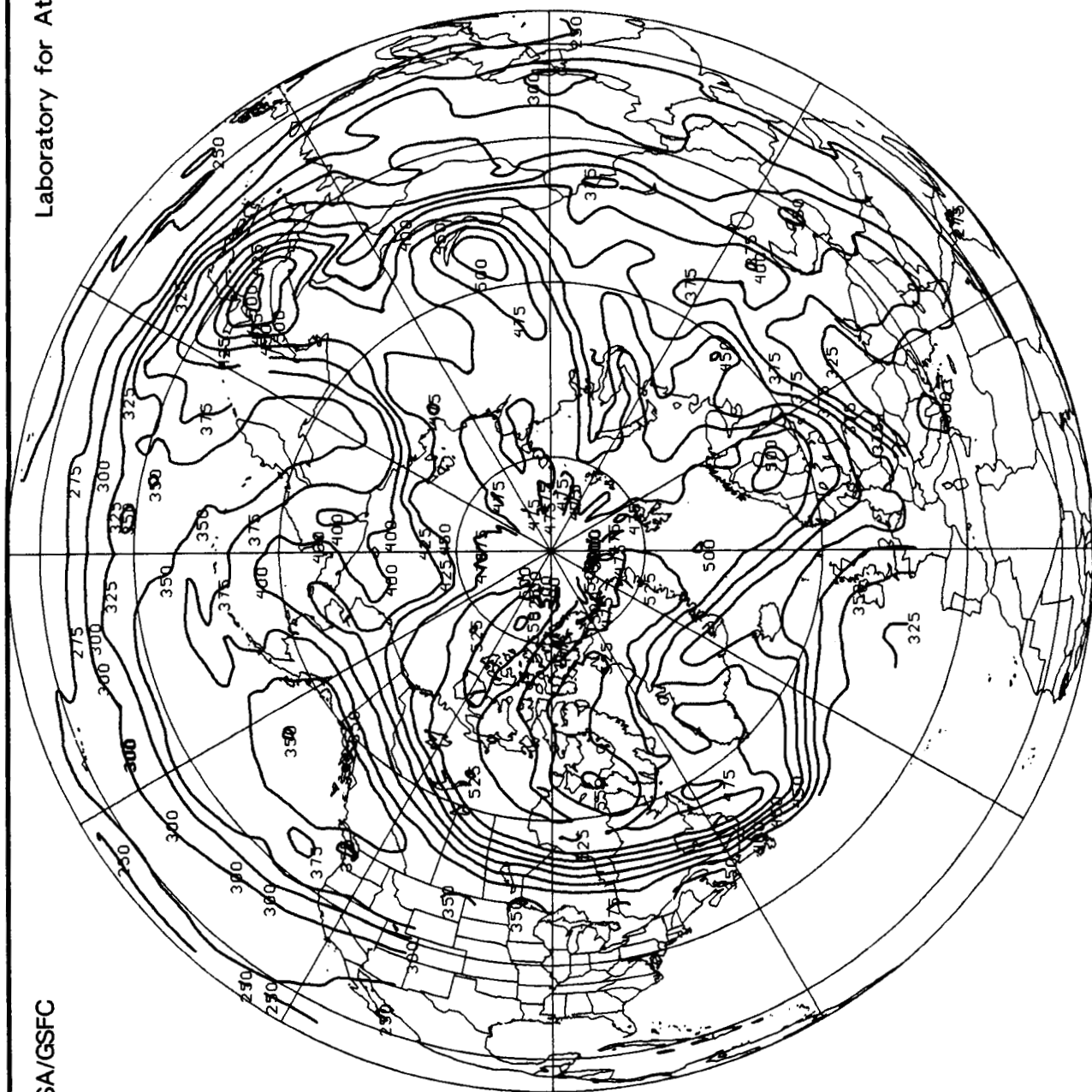


March 17, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

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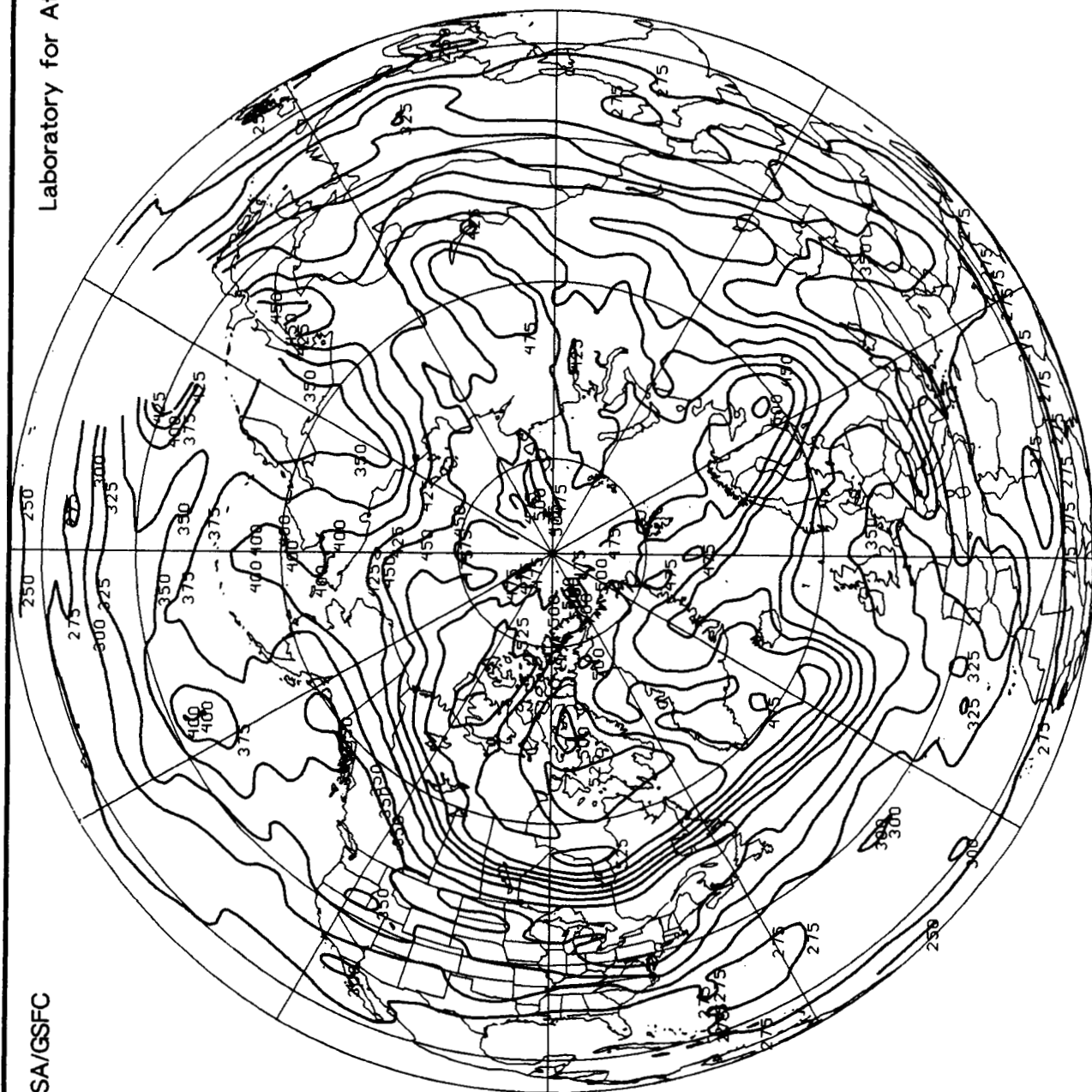


March 18, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

Laboratory for Atmospheres

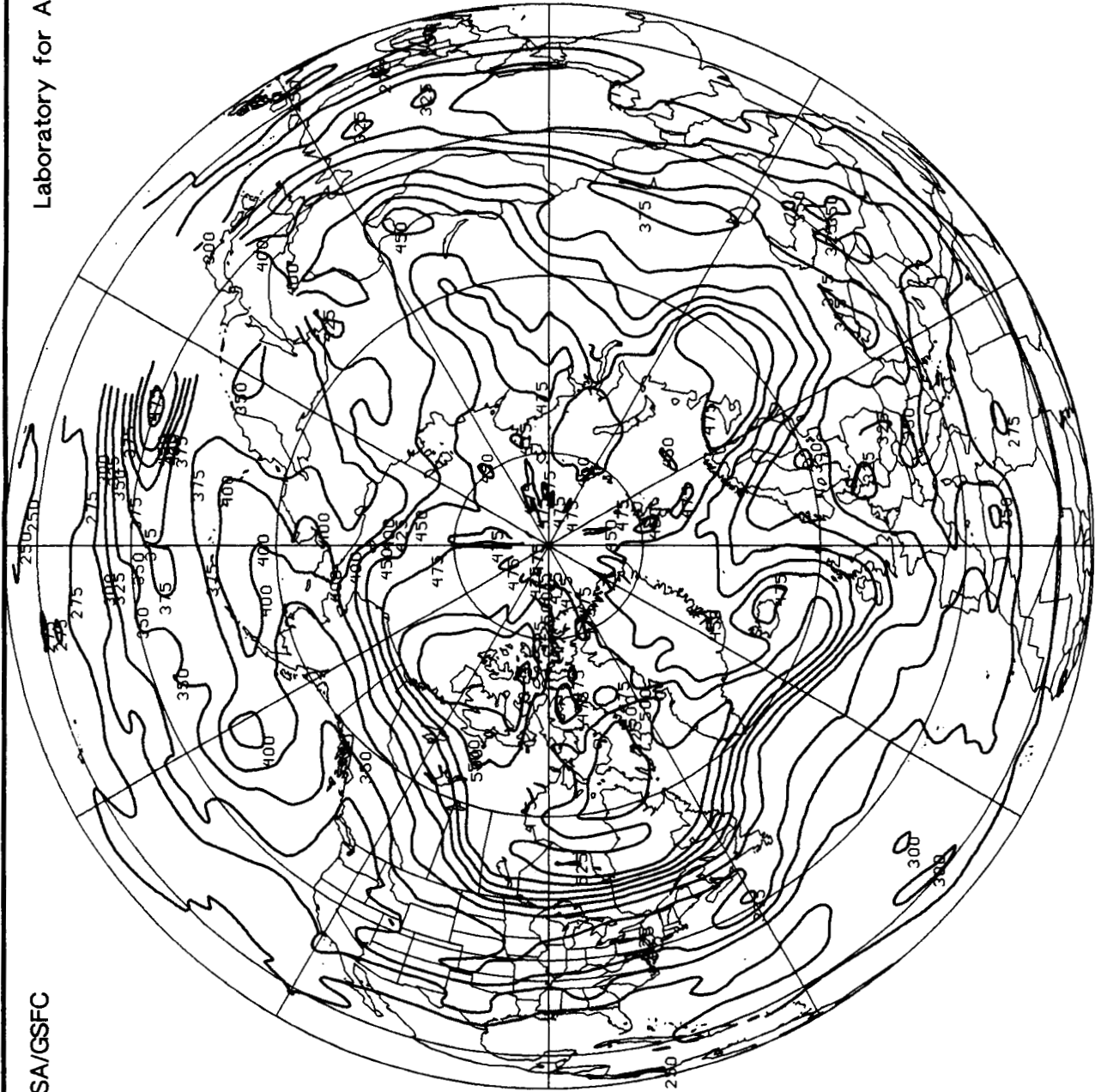


March 19, 1989

Gridded TOMS Ozone (Dobson Units)

NASA/GSFC

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March 20, 1989

Gridded TOMS Ozone (Dobson Units)

3.4 Monthly Mean Comparisons to Past Years

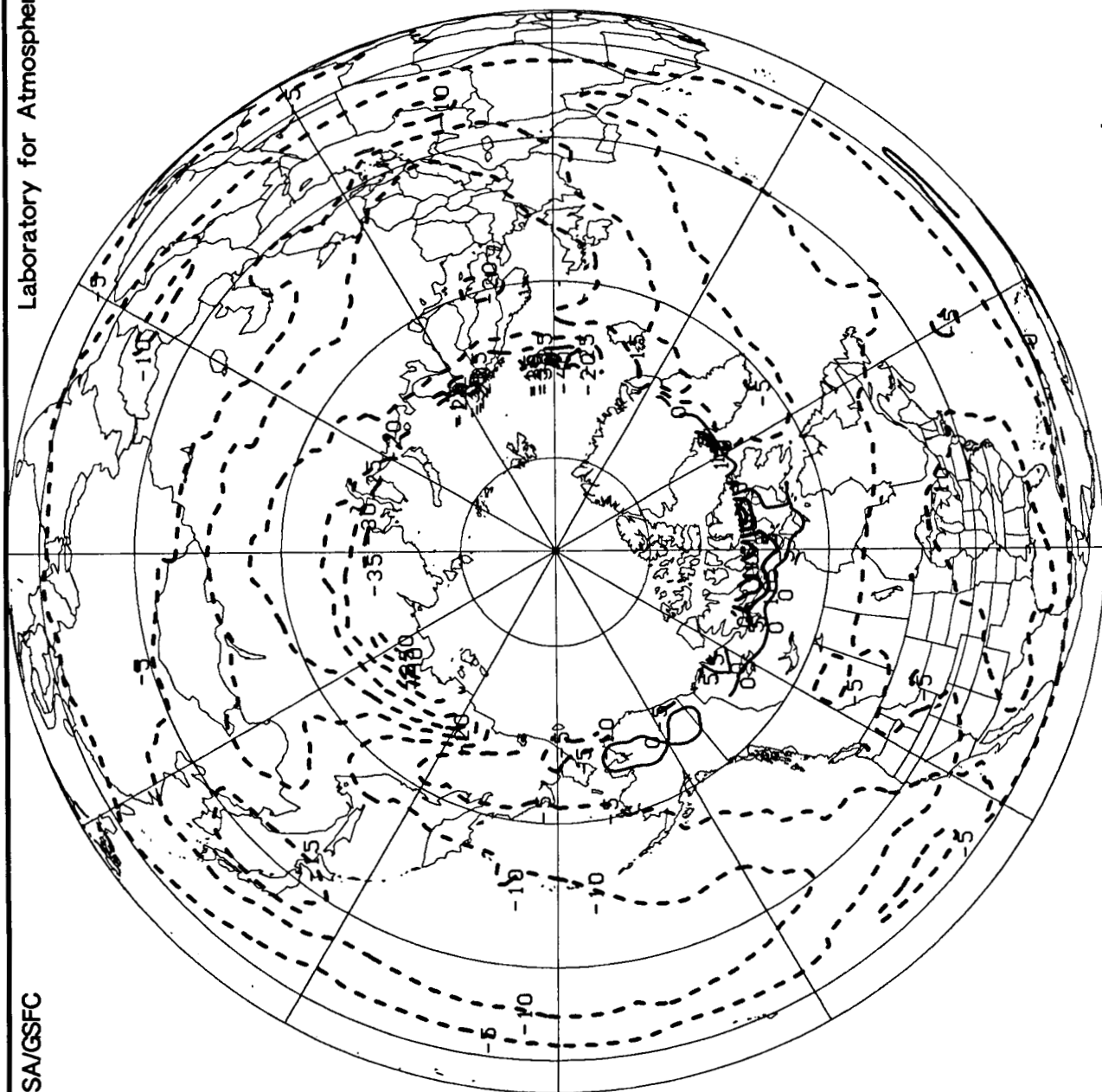
Figures 1a and 1b present the hemispheric differences between total ozone for the months of January and February 1989 and a four-year reference mean (1979 through 1982). In both cases, the values are in Dobson units with the differences expressed as the month in question minus the four-year mean. Isopleths are solid where this difference is positive and dashed where it is negative.

During January (Figure 1a), virtually the entire northern hemisphere is covered by negative differences. These differences are between 5 and 10 Dobson units over most of the hemisphere. Negative values as low as 40 DU are present near the terminator across Eurasia. Positive values up to 15 DU are present near the terminator across North America. A large area of negative differences greater than 10 DU exists across western Asia and much of the Pacific centered at latitude 40°N. A minimum difference of -15 DU is present near Japan and Korea. It should be noted that small negative differences could be explained by instrument calibration drift, which reduces uncorrected total ozone values by 4% over 10 years.

During February (Figure 1b), once again, much of the hemisphere is lowered by negative differences. These differences exceed 10 DU over large areas, including Southern Europe, Eastern and Central U.S., the North Pacific, Central USSR and Northern North America. Negative differences in excess of 20 DU exist over North Central USSR, Alaska and Northern Canada. A large area of positive differences exists over Northern Europe and the adjacent Atlantic. A small area of positive difference exists over Northwestern USSR.

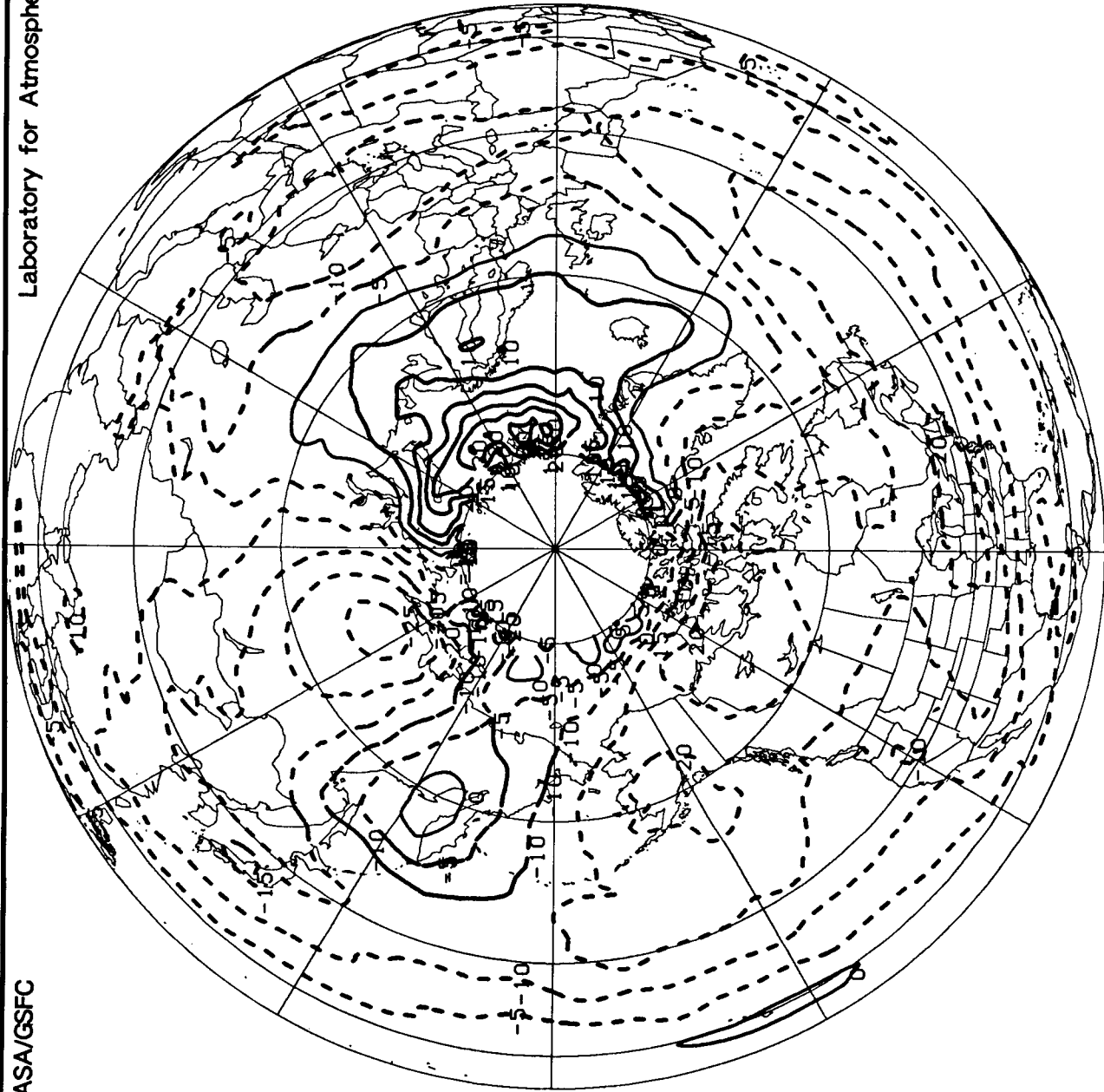
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January 1989 minus Reference Mean

Total Ozone (Dobson units)



February 1989 minus Reference Mean

Total Ozone (Dobson units)

4. REFERENCES

Krueger, A. J., P. E. Ardanuy, F. S. Sechrist, L. M. Penn, D. E. Larko, S. D. Doiron, and R. N. Galimore, 1988: The 1987 Airborne Antarctic Ozone Experiment: The Nimbus-7 TOMS Data Atlas, NASA Reference Publication 1201, 252 pages.

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5. ACKNOWLEDGEMENTS

The Nimbus-7 TOMS total ozone data were reliably and regularly supplied to the Airborne Arctic Stratospheric Expedition operations office in Stavanger, Norway. The quality, timeliness, and dependability of the near-real-time and delayed TOMS data sets permitted the TOMS total ozone observations to play a crucial role in the planning and successful completion of the aircraft flights. Without question, the reliable provision of the orbital and hemispheric TOMS observations played a central role in the outstanding success of the mission. The authors were provided assistance by many individuals during the course of the experiment. Without this help, the TOMS total ozone data could not have been delivered in a punctual manner, and indeed, the experiment may not have been possible. While it is not possible to name every individual who played a role, certain acknowledgements must be made.

The authors would like to express their appreciation to John Sissala, Mike Doline, and other members of the GE/RCA Service group for scheduling the data transfer from the Nimbus-7 satellite passes so as to obtain the telemetry in the quickest possible manner and for providing predictions of the Nimbus-7 orbital overpasses well in advance of the experiment. We also wish to thank Hal Domchick and Evelyn Hopkins of NASA/GSFC and the RMS Associates operations group for the smooth and continuous operations of the NSESCC during the experiment, and for adjusting the system maintenance schedule and job priorities to ensure the most rapid throughput of the TOMS data production on the IBM 3081. Also to be recognized are Zia Ahmad, Jesse Williams, Carlos Hester, Rekka Ambardeka, Carol Jones, and Barie Kelley of STX who processed the raw TOMS data on the GSFC IBM 3081. Recognition is due to Robin Tomlinson of RDS for her work in the final processing and plotting of the near-real-time ozone data at GSFC. We are also grateful to Brenda Vallette of RDS for the technical editing and assembly of this manuscript. Finally, we also wish to thank Arnie Oakes and Daesoo Han of NASA/GSFC for helping to put together this uniquely qualified group of individuals that made the mission work.

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Report Documentation Page

1. Report No. NASA RP-1227		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle The 1989 Airborne Arctic Stratospheric Expedition Nimbus-7 TOMS Data Atlas				5. Report Date July 1989	
				6. Performing Organization Code 616	
7. Author(s) Arlin J. Krueger, Lanning M. Penn, David E. Larko, Scott D. Doiron, and Patricia T. Guimaraes				8. Performing Organization Report No. 89B00188	
				10. Work Unit No.	
9. Performing Organization Name and Address Goddard Space Flight Center Greenbelt, Maryland 20771				11. Contract or Grant No. NAS5-29373	
				13. Type of Report and Period Covered Reference Publication	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546-0001				14. Sponsoring Agency Code	
15. Supplementary Notes Arlin J. Krueger is with Goddard Space Flight Center, Greenbelt, MD; Lanning M. Penn and David E. Larko are affiliated with Research and Data Systems Corporation, Greenbelt, MD; and Scott D. Doiron and Patricia T. Guimaraes are affiliated with ST Systems Corporation, Vienna, VA.					
16. Abstract Over the past several years, world scientific attention has been focussed on the rapid and unanticipated decrease in the abundance of ozone over Antarctica during the Austral spring. A major aircraft campaign was conducted from December 1988 to February 1989 in response to the recently published Ozone Trends Panel Report which found that the largest decreases in Arctic ozone occurred during January to February at latitudes near the edge of the Arctic vortex. This atlas provides a complete set of TOMS ozone measurements over Europe and the North Atlantic for the duration of the experiment. These were the orbital TOMS measurements provided to the experimenters in near-real-time. In addition, a set of northern hemisphere TOMS ozone measurements for the period December 26, 1988 to March 20, 1989 is presented. A comparison of January and February 1989 mean ozone values to prior years is also presented.					
17. Key Words (Suggested by Author(s)) Arctic Stratospheric Expedition, Nimbus-7, total ozone, Total Ozone Mapping Spectrometer			18. Distribution Statement Unclassified - Unlimited Subject Category 47		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of pages 156	22. Price A08		